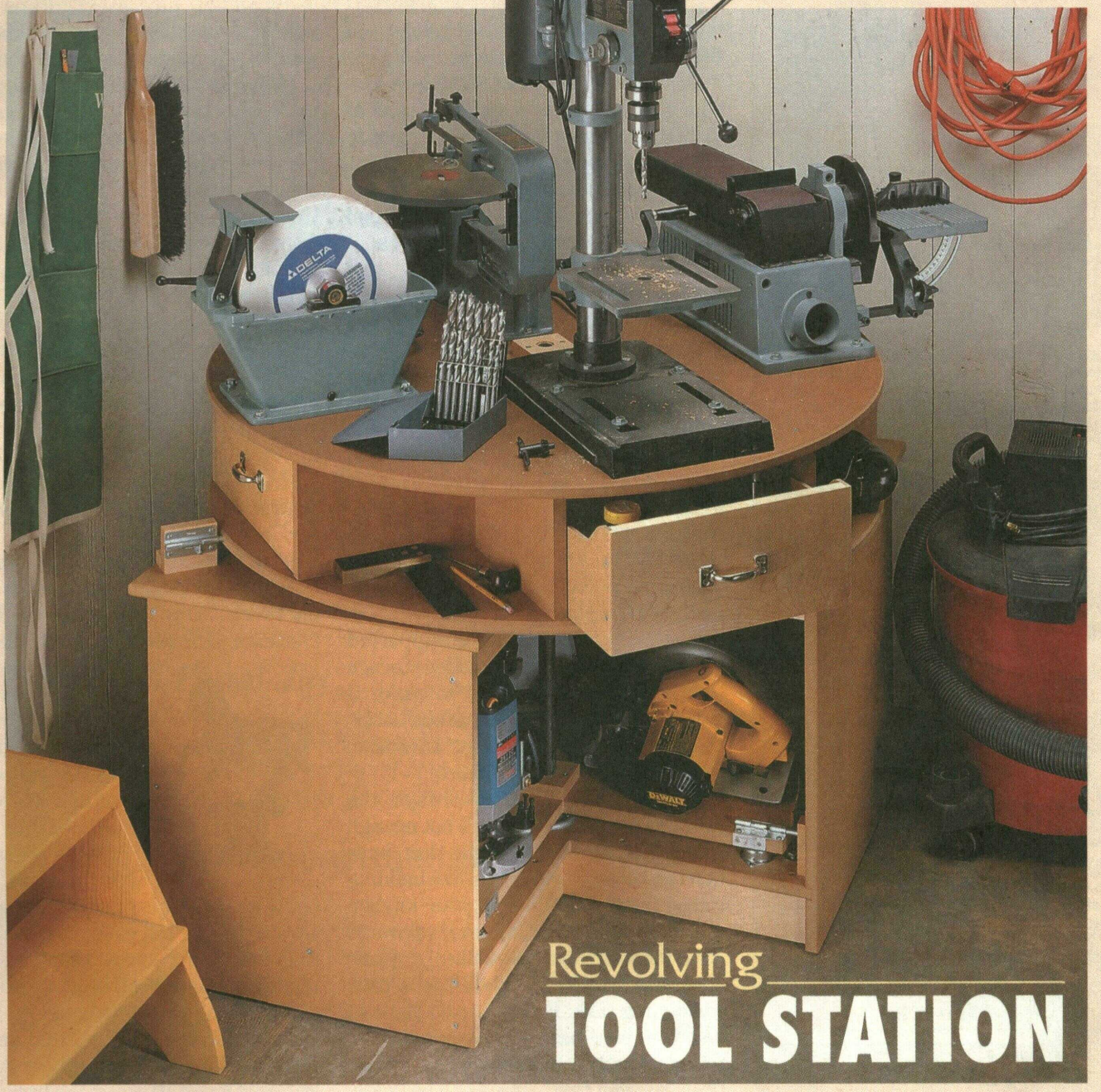
Building
RAISED
PANEL DOORS

TIPS-TOOLS'TECHNIQUES

ShopNotes®

Vol.6 Issue 35



Revolving TOOL STATION

- Torpedo Level
- Frame and Panel Jig
- Stile and Rail Bits
- Shop-Tested Tips

DISPLAY UNTIL OCTOBER 20 05>
o""09281"02994""6'
PRICE $4.99

ShopNotes®
Issue 35 September 1997

PUBLISHER Donald B. Peschke
EDITOR Tim Robertson
ASSOCIATE EDITOR PhilTotten
ASSISTANT EDITOR Bryan Nelson
ART DIRECTOR Gary Christensen
SR. GRAPHIC DESIGNER KIU't Schultz
SENIOR ILLUSTRATORS Roger Ftei land, Mark Higdon

CREATIVE RESOURCES

Creative Director: Ted Kralicek • *Project Developer:* Ken Munkel • *Project Designers:* Ted Wong, Kevin Boyle • *Project Coordinator-.* Kent Welsh • *Shop Mgr.:* Steve Curtis • *Shop Craftsman:* Steve Johnson • *Photography Director:* Lark Smothermon * *Sr. Photographer:* Crayola England

BOOKS

Executive Editor: Douglas L. Hicks • *Art Director:* Linda F. Vermie • Sr. *Graphic Designer:* Chris Glowacki

CIRCULATION

Sub. Serv. Dir.: Sandy Baum • *New Bus. Dir.:* Glenda Battles • *Renewal Mgr.:* Paige Rogers * *Billing Mgr.:* Rebecca Cunningham • *Asst. Sub. Mgr.: Joy* Krause • *Promotion Asst:* Rick Junkins • *Single Copy Mgr.:* Todd L. Bierle • *Assoc. Graphic Design Dir.:* Susie Rider • Sr. *Graphic Designer:* Cheryl L. Simpson

CORPORATE SERVICES

Vice Pres. of Planning & Finance: Jon Macarthy • *Controller:* Robin Hutchinaon • Sr. *Acct:* Laura Thomas • *Accts. Payable Clerk:* Mary Schultz • *Prod. Dir.:George* Chmielarz • *Elect. Pub.:* Douglas M. Lidster • *Prod. Asst:* Susan Dickman • *Prod. Artist:* Jon Snyder • *Pre-Press Image* Spec.:Troy Clark • *New Media Mffr.:Gord.anC.GFdppe* • *Multimedia Art Dir..* Eugene Pedersen • *Net Admin.:* AlBarnes • *I.S. Support Asst:* Chris Harrison* *H.R.Dir.:* Joyce Moore * *H. R. Asst.:* Kirsten Koele • *Admin. Asst:* JuliaFish • tfecep(.:JeanneJohnson,SherylRibbey • *Bldg. Maint.:* Ken Griffith • *Special Proj. Dir.:* Saville H. Inman

MAILORDER

Operations Dir.: Bob Baker • *Mat'ls Mgr.:* Mark Mattiussi • CwstSe™^M(/?::JennieEnos» *Warehouse Supervisor:* Nancy Johnson • *Buyer:* Linda Jones • Op. *Asst.:* Tammy Aldini • *Team Leader:* Karla Eslinger • *Tech. Rep.:* Matthew TeRonde* Ci^Sen^fi^_'AnnaQ)x,MargoPetrus,Tamn^ Truckenbrod, Adam Best, Nancy Downey, Deborah Rich • *Warehouse:* Chuck Carlson, Sylvia Carey, **Larry** Prine

ShopNotes® (ISSN 1062-9696) is published bimonthly (Jan., March, May, July, Sept., Nov.) by August Home Publishing, 2200 Grand, Des Moines, IA 50312.
ShopNotes® is a registered trademark of August Home Publishing **©Copyright** 1997 by August Home Publishing. All rights reserved.
Subscriptions: Single copy: $4.99. One year subscription (6 issues), $24.95. Canada/Foreign add $5 per year.
Periodicals Postage Paid at Des Moines, IA and at additional mailing offices.
Postmaster: Send change of address to *ShopNotes*, P.O. Box 37103, Boone, IA 50037-2103.
Subscription Questions? Write to: *ShopNotes* Customer Service, P.O. Box 842, Des Moines, IA 50304-9961. Or call 1-800-333-5854, 8:00 am to 5:00 pm, Central Time, weekdays. FAX 515-283-0447
E-Mail: ShopNotes@shopnotes.com
Internet: http://www.shopnotes.com

PRINTED IN U.S.A.

WoodNet™
NOWONTHEWBB!
- 50 Woodworking Tips Online
- Woodworking Techniques — Step-by-Step
- Project plans you can download
- WoodNet Forum — Woodworkers' Q & A
- Power Tool Reviews

Point your browser to: **http://www.augusthome.com**
Select "Woodworking" from the Welcome Page menu.

EDITOR'S NOTE

Cutoffs

If I had to put together a wish list for my shop, I could tell you my first choice in a heartbeat — more space.

Now there's no harm in wishing. But the reality is my shop is shoehorned into the basement — right between the laundry room and storeroom.

So unless I carve out some new territory (which is about as likely as winning the lottery), I'm going to have to get by with the space that's available.

In the meantime, I'm always on the lookout for ways to solve the problem of having a limited amount of space.

TOOL STATION. The revolving tool station featured on page 16 is one solution. It only takes up *nine* square feet of space. Yet it combines a workstation for your benchtop tools as well as storage for portable power tools.

Benchtop tools are mounted in a cluster on a circular platform that spins around like a carousel. This means you can position the tool you're working at directly in front of you while the others are out of the way. When you need to use a different tool, just give the platform a spin.

The revolving platform is supported by a base cabinet that provides storage for portable power tools. To make it easy to remove a tool (or put one back), they're stored on a large turntable that rotates like a lazy susan.

TIME. But space isn't always the problem. Sometimes there's not enough *time* to start big projects that have been on the back burner—like building raised panel doors for all your kitchen cabinets (the type a cabinet shop would build for a kitchen remodeling project).

Granted, this may seem like a time consuming task. But it doesn't have to be. You just have to borrow a few tricks from the big production shops. (For more on this, refer to page 12.)

STILE & RAIL BITS. For example, you can cut the joinery for the frame *and* the profile along the inside edge at the same time. While commercial shops use a shaper for this, the same thing can be accomplished with a router and a set of stile and rail bits, see page 24.

FRAME & PANEL JIG. As long as you're in "production mode," you'll want to glue up the doors quickly too. So don't overlook the frame and panel jig shown on page 28. Besides being a time-saver, it allows you to glue up a frame and panel door that's perfectly flat.

TORPEDO LEVEL. One final project in this issue that I'm pretty fond of is a small torpedo level, see page 6. With a walnut body that tapers at the ends and polished brass plates, it has the look and feel of a traditional level.

But don't build the level just for its appearance. There's also a eleven**" spring-loaded system that lets yoifJP recalibrate the level if it ever gets knocked out of adjustment.

FINE TOOL JOURNAL. While we were building the level, I got curious about old levels. So to find out more, I gave Clarence Blanchard a call at the *Fine Tool Journal.*

The *Journal* (as he calls it for short) is as unique as its logo shown at left. It's a magazine that's dedicated to providing information about old tools. And it even offers an auction service so you can collect old tools. (To find out more about the *Fine Tool Journal,* you can call 800-248-8114.)

Well, to make a long story short, Clarence not only gave me the information I needed. He also put together the collection of levels shown on the back cover.

Tim

Contents

Tools & Techniques

Building Raised Panel Doors ____ 12

Building a number of raised panel doors? You can use a special set of router bits to make the frame and the raised panel quickly and easily.

Stile & Rail Pits ____ 24

A matched set of stile and rail bits and a router table. That's all it takes to cut the joinery and create the decorative profile on the frame of a raised panel door.

Projects

Torpedo Level ____ 6

Made of highly figured walnut and brass, this torpedo level has the look and feel of a traditional hand tool. With a unique, built-in adjustment system, you can calibrate the level quickly and accurately.

Revolving Tool Station ____ 16

Just give the circular platform on top of this station a spin to position the tool you want to use right in front of you. A rotating turntable in the base provides easy access to your portable power tools as well.

Frame & Panel Jig ____ 28

This shop-built jig solves the biggest problem of gluing up a frame and panel door — keeping the door perfectly flat. The secret is a pair of cams that apply clamping pressure directly in line with the frame.

Departments

Readers' Tips ____ 4

Our readers offer their own shop-tested tips for solving some of the most common woodworking problems.

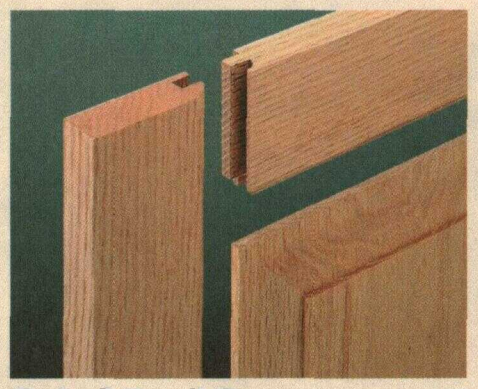
Shop Solutions ____ 26

Use these tips from the guys in our shop to get professional-looking results on the projects in this issue.

Sources ____ 31

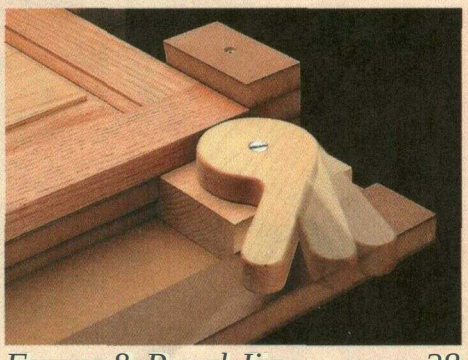
Hardware, supplies, and mail order sources for the projects in this issue. Also, a selected guide to past projects from ShopNotes that's sure to come in handy.

Torpedo Level *page 6*



Raised Panel Doors *page 12*

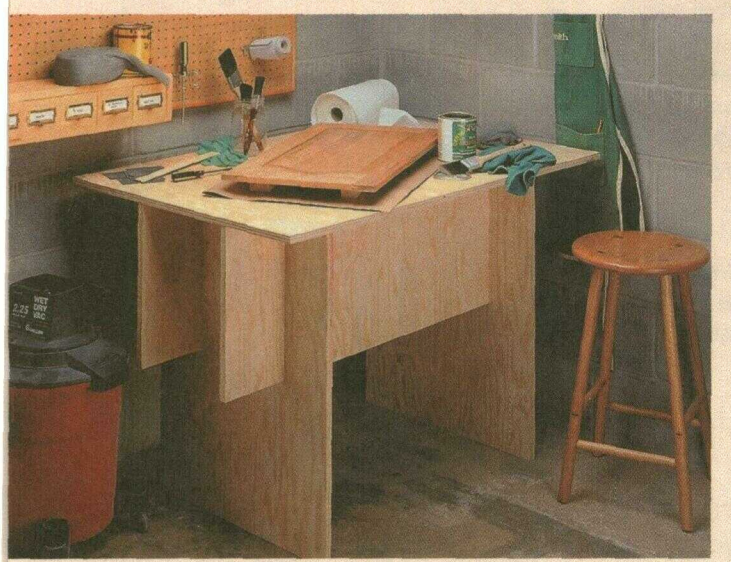
Tool Station *page 16*

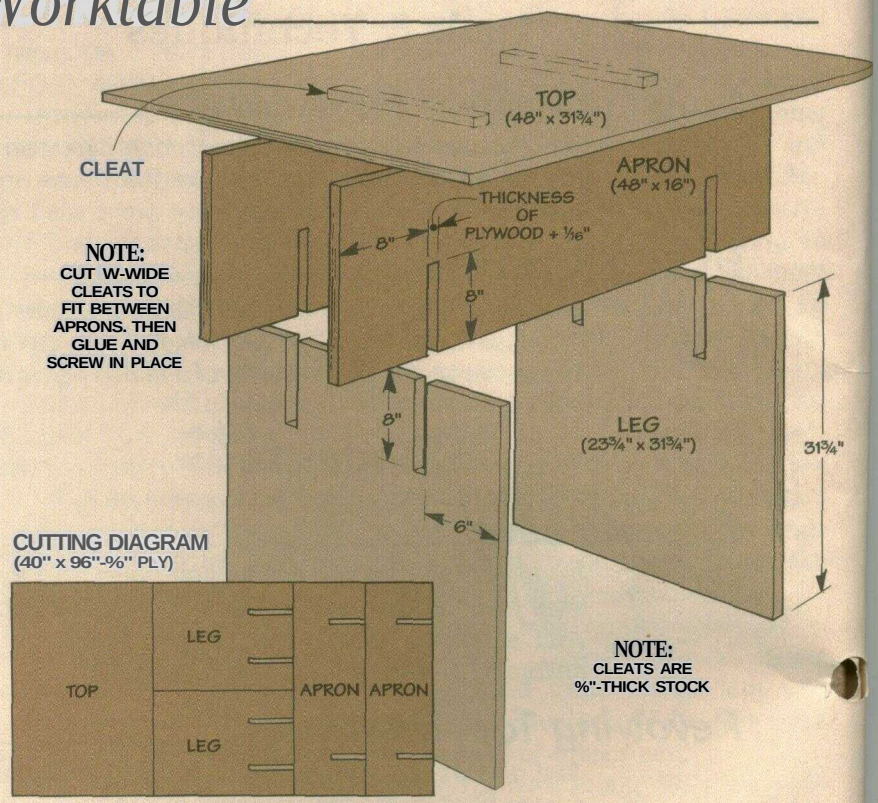


Frame & Panel Jig *page 28*

Readers' Tips

Knock-Down Worktable





• It's always handy to have an extra worksurface when finishing or assembling a project. The only drawback is it often takes up too much space.

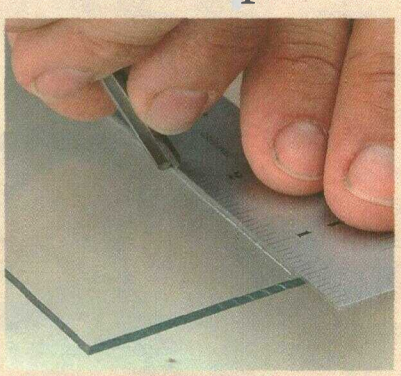
This knock-down worktable solves that problem, see photo. It can be assembled or taken apart in less than a minute, then stacked flat against a wall.

The *legs*, *aprons*, and *top* of the table are cut from a single sheet of plywood, see drawing.

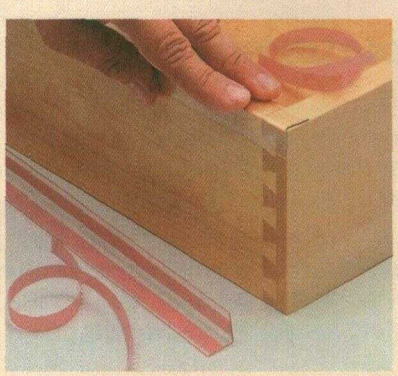
To create a sturdy worksurface, the legs and aprons are held together with interlocking notches. Cutting two *cleats* to fit between the aprons and attaching them to the top prevents it from sliding off.

Vernon Harris
Utica, New York

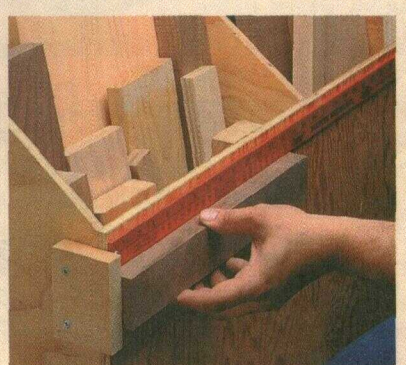
Quick Tipe



A *When cutting pieces of glass to size, Michael Burton of Ogden, Utah scores a clean "break line" with a carbide-tipped router bit.*

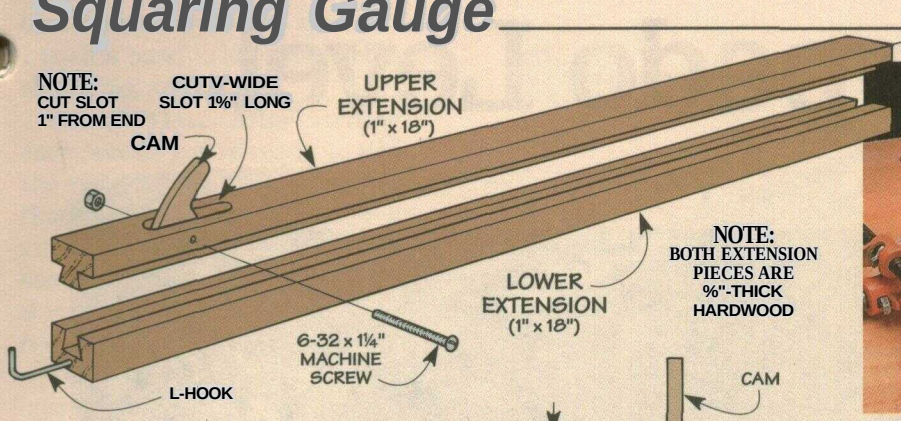


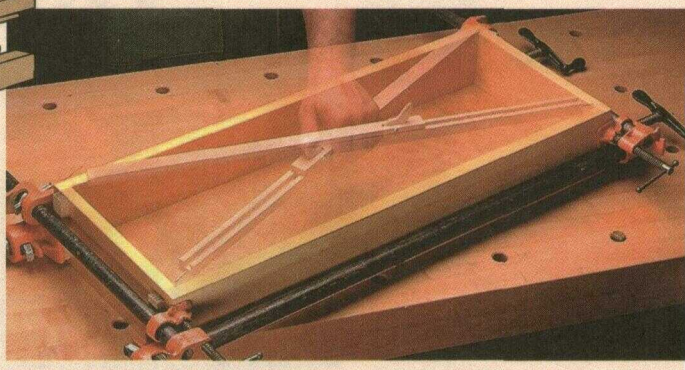
A *For inexpensive drawer glides Lonie Richardson, Jr. ofPemnton, Michigan uses short lengths of plastic wallpaper comer bumper.*

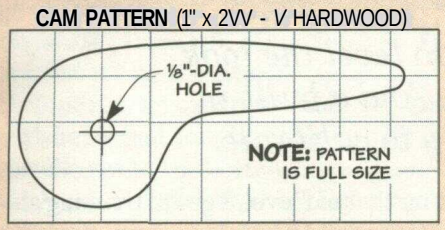


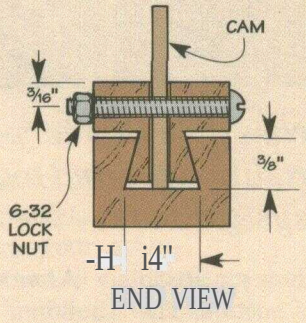
A *Attaching a yardstick and stop to a cutoff bin helps Howard Moody of Upper Jay, NY quickly sort pieces to find the one he needs.*

Squaring Gauge









• It's easy to check whether a drawer or cabinet is square. Simply compare the length of the two diagonals. But it can be difficult getting the end of a tape measure into the corners for an accurate reading. So I use this adjustable squaring gauge, see photo.

The gauge consists of an *upper* and *lower extension* that are held together with a sliding dovetail joint, see drawing. (I used a 14° dovetail bit to rout the groove and the matching tongue.)

By sliding the pieces against each other, you can adjust the length of the gauge. Note: An L-shaped hook in the end of each piece allows you to fit the gauge into the corner of a project.

CAM. Once the gauge is adjusted for the first diagonal, tightening a simple cam "saves" the setting so you can check the second one.

The cam is an irregular-shaped piece of hardwood (see pattern) that fits in a slot in the upper extension. After attaching it with a machine screw and lock nut, raise the cam to lock the gauge in place.

Dario Brisighella, Sr.
Oak Creek, Wisconsin

Inlay Cutter

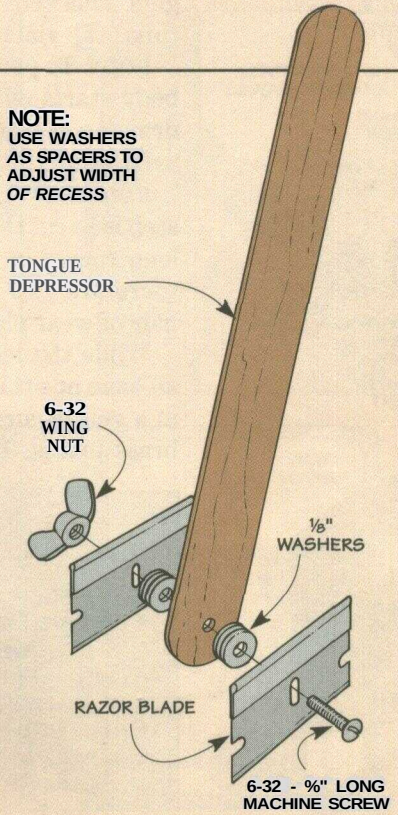
• When working with thin wood veneer, I often inlay narrow strips of contrasting veneer in a shallow recess. To score lines for this recess that match the width of the strip exactly, I use this simple cutter, see drawing.

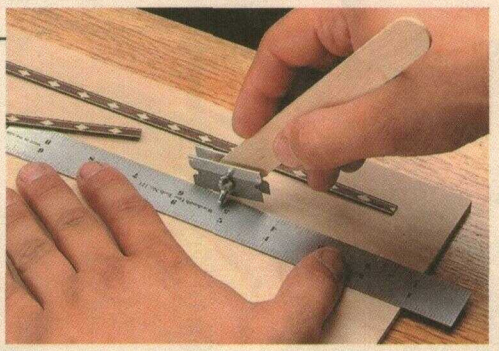
The cutter consists of two single-edged razor blades attached to a tongue depressor.

By slipping flat washers between the blades and the handle, the width of the cutter can be adjusted for inlay strips of different widths.

To cut a recess for a strip, simply follow a straightedge while applying even pressure on the razor blades. Then remove the waste with a chisel.

R.B. Himes
Vienna, Ohio





Send in Your Solutions

To share your original solutions to problems you've faced, send them to: *ShopNotes*, Attn.: Readers' Tips, 2200 Grand Avenue, Des Moines, IA 50312. (Or if it's easier, FAX them to us at: 515-282-6741.)

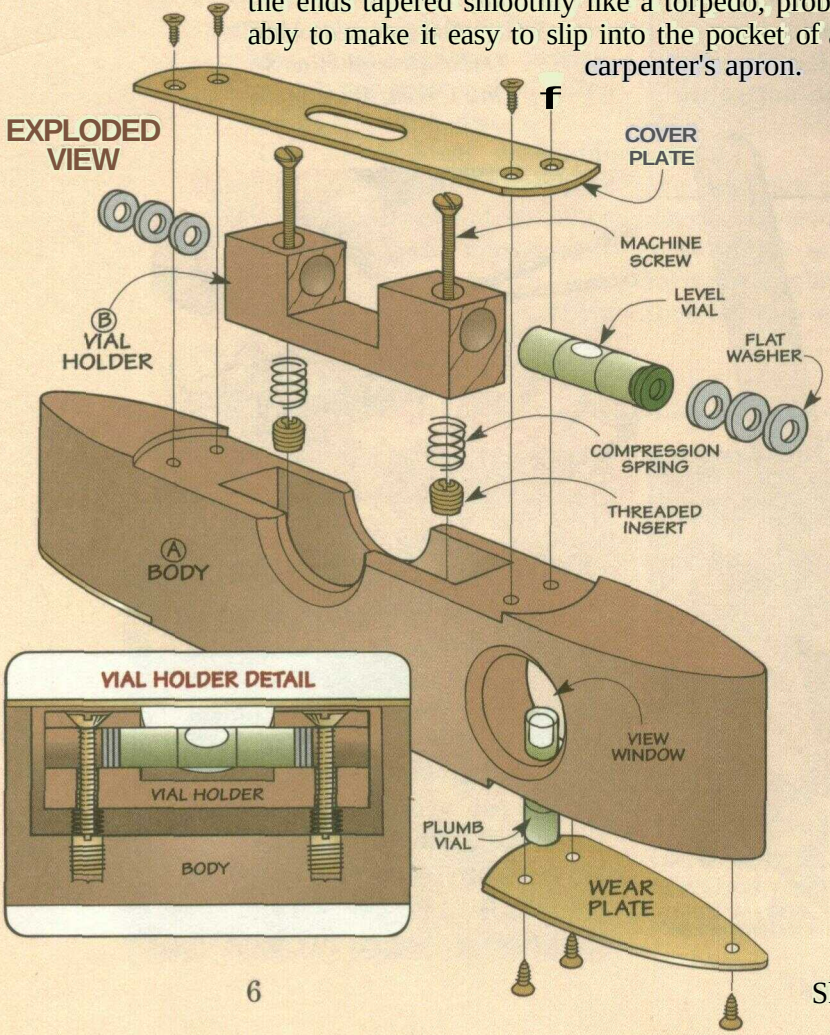
We'll pay up to $200 depending on the published length. Please include a daytime phone number so we can call you if we have any questions.

Torpedo Level

Walnut and brass give this torpedo level the look and feel of a traditional hand tool. And a built-in adjustment system makes it easy to calibrate.

Recently, a Mend dropped by to show me an old level he had picked up at a tool auction. The body of the level was dented and scratched. And one of the vials was broken.

But in spite of its rough condition, I still admired the workmanship that had gone into the level. Brass plates fit flawlessly into the wood body. And the ends tapered smoothly like a torpedo, probably to make it easy to slip into the pocket of a carpenter's apron.



After seeing that old level, I got to thinking about building a "torpedo" level of my own, see photo. Like the original, this level has a tapered wood body with brass accent strips. And two vials make it handy for leveling vertical or horizontal surfaces.

ADJUSTMENT SYSTEM. But the thing that's unique about this level is a built-in adjustment system. The vial that's used to level a horizontal surface is cradled in an adjustable holder, see drawing at left. This allows you to calibrate the level without a lot of fiddling around. And if it ever gets knocked out of adjustment, you can "fine tune" the vial in a matter of minutes.

BODY. To provide a stable base for the level, the body starts out as a 1"-thick hardwood blank, see drawing at top of next page. (I used a piece of figured walnut I'd been saving for a special project.)

RECESSES. To accept the brass plates, the next step is to cut three shallow recesses in the blank. A long recess in the top accepts a cover plate, and there are two short recesses in the bottom for a pair of wear plates.

While the length of these recesses varies, they all have one thing in common. The ends are shaped in a gentle curve where the wood body meets the brass plates. To ensure that this shape is consis-

Hardware

- *(2) S>-32 x 1V Flathead Machine Screws (Brass)*
- *(6) '/e" Flat Washers*
- *(2) 8-32 Threaded Inserts (Brass)*
- *(2) '/z"-Long x W I.D. Compression Springs*
- *(2) $^{3}/_{B}$" x 1'/$_{4}$" Bubble Vials*
- *(1) 1" x 10" Braes Strip C'l,g" thick)*
- *(10) #4 x </4" Fh Screws (Brass)*

To order a complete hardware kit, refer to page 51.

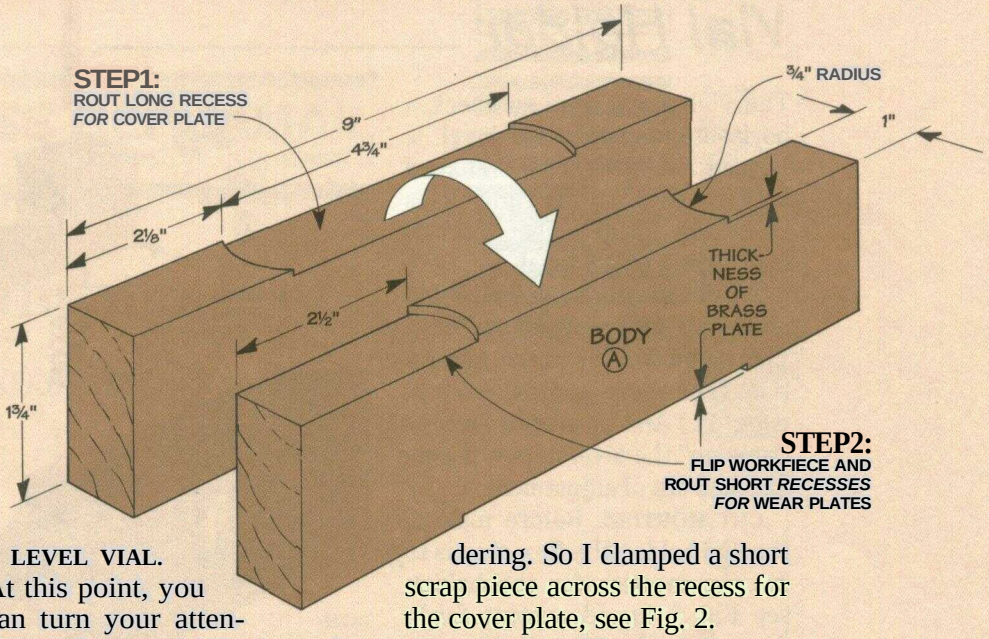
tent from one recess to the next, 11 used a hand-held router and a simple jig, see page 26.

PLUMB VIAL. After routing each recess, you're ready to add the vial near the end of the level that's used to check whether a vertical surface is plumb. (For sources of vials and other hardware needed to build this level, see page 31.)

The plumb vial fits in a stopped hole that's drilled in the bottom edge of the level, see Fig. 1. (One of the brass plates will cover the hole when it's added later.)

To produce an accurate reading, it's important that this hole is perpendicular to the bottom edge of the level. So start by checking that the table on your drill press is square to the bit, see margin at right. Then drill the hole using slow, steady pressure.

WINDOW. In addition to the stopped hole, a large hole drilled through the sides of the level creates a "window" that lets you see the vial. (I used a Forstner bit to make a clean cut.)

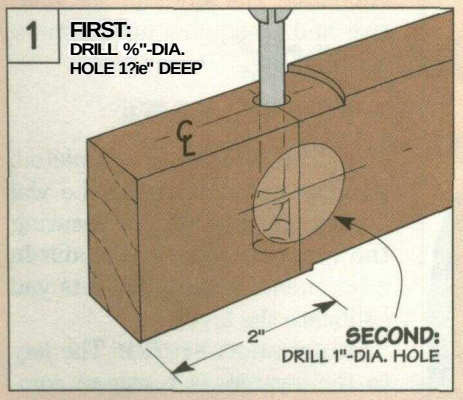


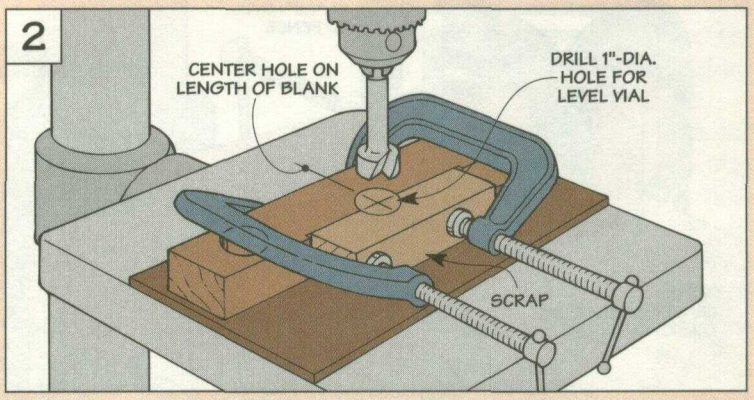
LEVEL VIAL. At this point, you can turn your attention to the top vial that's used to level a horizontal surface.

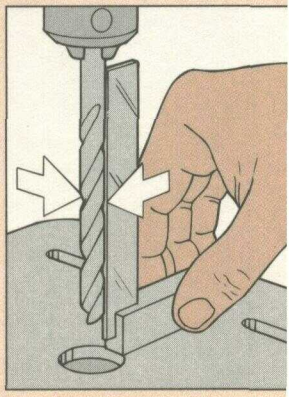
To provide a clear view of the level vial, there's a semi-circular opening in the top edge of the level. Here again, a Forstner bit produces a clean cut. Even though it's designed to drill a hole on the edge of a workpiece, I still wanted to provide extra supportto keep the bit from wandering. So I clamped a short scrap piece across the recess for the cover plate, see Fig. 2.

CHAMFERS. The scrap comes in handy for the next step as well —routing an Vs" chamfer around the rim of the hole on both sides, see Figs. 3 and 3a. While you're at it, chamfer the view window near the end of the level too.

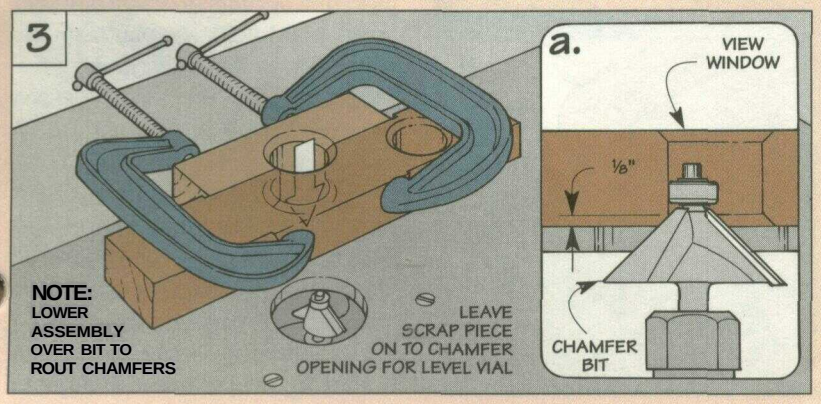
INSTALL PLUMB VIAL. Now all that's left to install the plumb vial. To do this, simply press the vial into the hole, see Fig. 4.

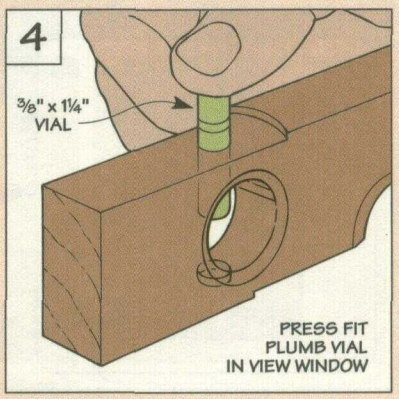






To ensure that the drill press table is square to the bit, use a square to check it in both directions.





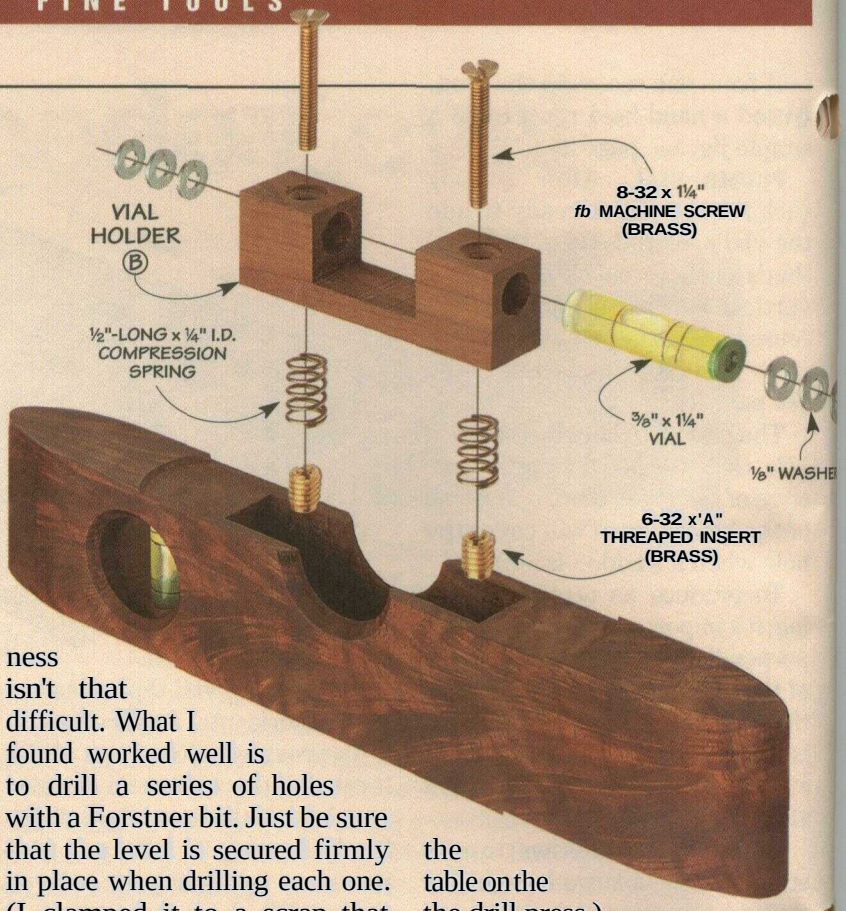
Vial Holder

The vial that's used to check a horizontal surface for level is housed in a small U-shaped holder, see photo at right. This holder fits inside a deep mortise in the body of the level.

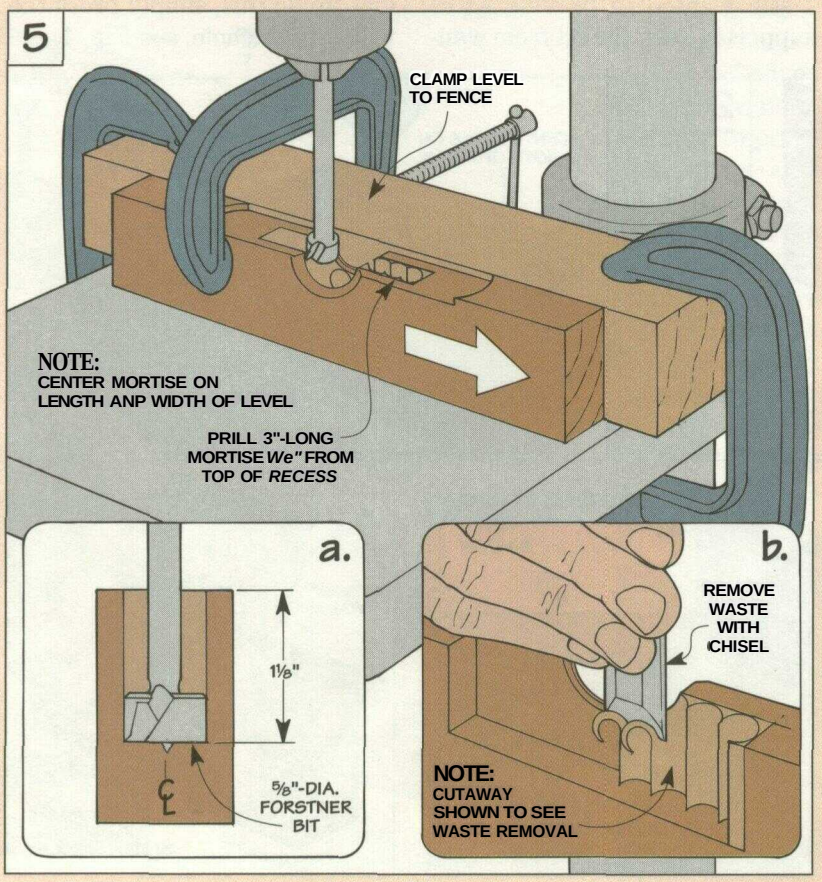
ADJUSTABLE. The unique thing about this holder is it's *adjustable.* This simplifies the initial calibration. (For more on this, refer to page 11.) And it allows you to "tune up" the level in case it gets knocked out of adjustment.

CUT MORTISE. Before making the vial holder, the first step is to cut the mortise for the holder, see Fig. 5. Besides being fairly deep (1"), this mortise is also quite wide (%")• This means that the sides of the level near the opening for the level vial will only be $^{3}/_{16}$" thick. As a result, any variation in thickness will be quite noticeable.

Fortunately, cutting the mortise so each side is identical in thickness isn't that difficult. What I found worked well is to drill a series of holes with a Forstner bit. Just be sure that the level is secured firmly in place when drilling each one. (I clamped it to a scrap that was squared up and attached to the table on the the drill press.)


VIAL HOLDER (B)
8-32 x 1¼" fb MACHINE SCREW (BRASS)
½"-LONG x ¼" I.D. COMPRESSION SPRING
⅜" x 1¼" VIAL
⅛" WASHE
6-32 x'A" THREAPED INSERT (BRASS)

After removing most of the waste, it's just a matter of using a chisel to clean up the ridges on the sides of the mortise and to square up the ends, see Fig. 5b.



VIAL HOLDER

Once the mortise is completed, you can concentrate on the vial holder. In addition to securing the vial, the holder has a built-in adjustment system that lets you calibrate the level.

ADJUSTMENT SYSTEM. The key to this system is a pair of compression springs (like you'd find in a ball point pen), see photo above. Each spring fits over the end of a machine screw that passes through the vial holder and into a threaded insert in the level.

As you tighten the machine screw, the spring compresses and exerts pressure on the bottom of the holder. By turning the screw, you can vary the amount of pressure. This moves the end of the holder up or down which adjusts

the position of the vial.

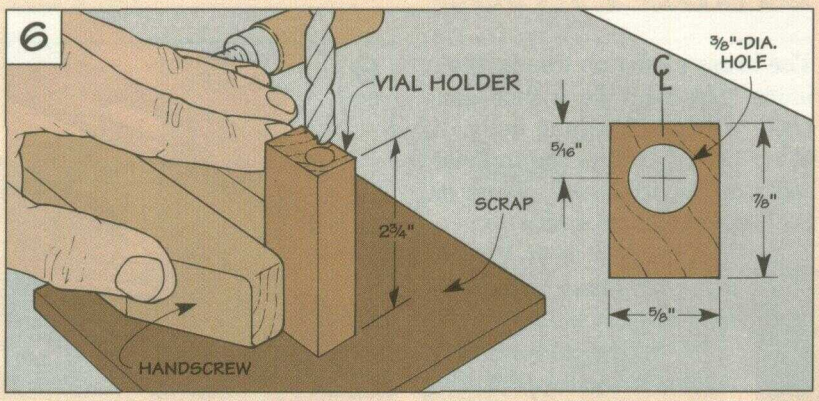
BLANK. Since the vial holder is quite small, it's safer and easier to start by planing an oversize blank to a thickness of %" (the width of the mortise). Then, after ripping it to final width (%"), you can cut the blank to length ($2\frac{3}{4}$"), see Fig. 6.

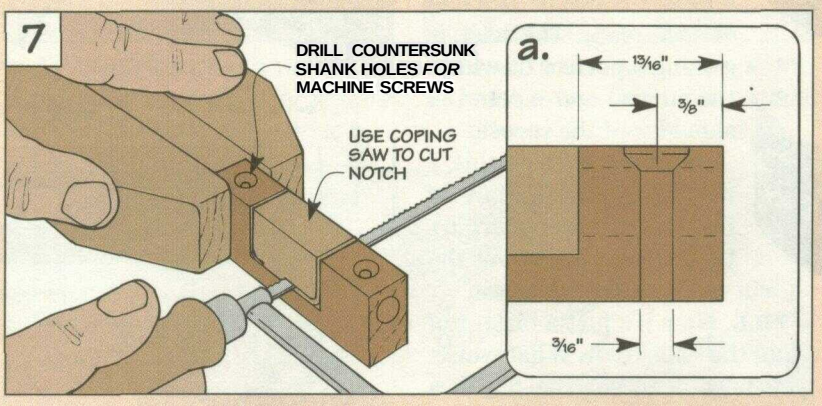
Once the blank is cut to size, the next step is to drill a hole through the ends to accept the level vial. Because you need to stand the blank on end, it's a bit tricky holding it by hand. But tightening the workpiece in a handscrew will hold it firmly in place, see Fig. 6.

NOTCH. Next, to create an opening in the holder that lets you see the vial, you'll need to cut a wide notch in the top edge, see Fig. 7. Again, since the piece is small, I used a handscrew to hold it in place and cut the notch with a coping saw. As before, a chisel makes quick work of cleaning up the corners.

At this point, you're just about ready to install the holder. But first, you'll need to drill two countersunk shank holes for the machine screws that hold it in place, see Fig. 7a.

These holes provide a handy way to establish the location of the threaded inserts. All you need to do this is to center the holder in the mortise and use a brad point bit to mark the location of each insert, see Fig. 8.



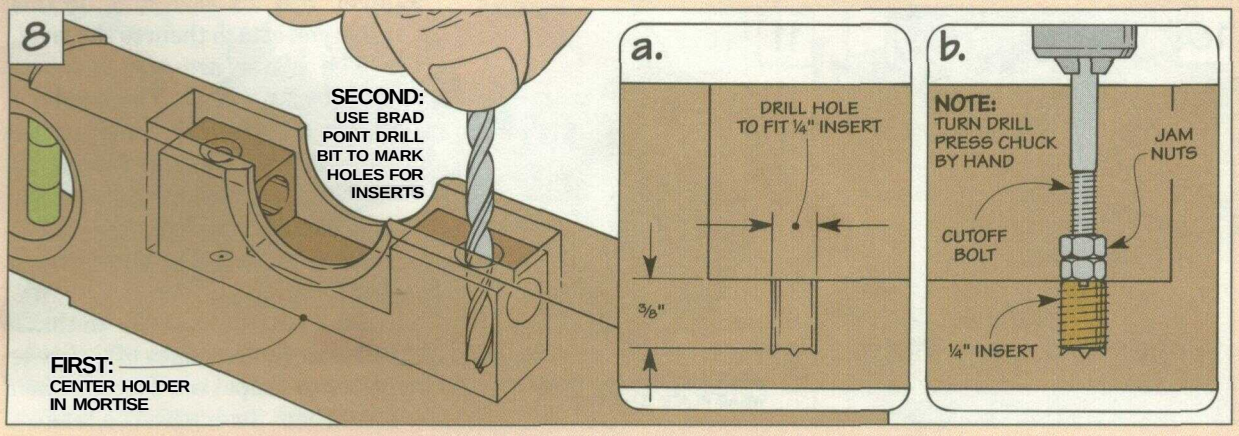


INSERTS. Drilling the holes for the threaded inserts is easy, see Fig. 8a. The trick is installing them so they go in nice and straight.

What worked well here is to start by chucking a cutoff bolt in the drill press and tightening two "jam" nuts on the end, see Fig. 8b. Then, with the end of the bolt threaded into the insert, rotate the chuck by hand to install the insert.

ASSEMBLY. With the inserts in place, you're ready to assemble the vial holder. The first step is to press the vial into the holder. To ensure that the indicator lines on the vial remain centered, I used small washers as shims. These washers fit between the ends of the vial and the machine screws, see photo on page 8.

Now all that's left is to install the vial holder. Although it may seem unusual at first, the best way to do this is to hold the vial holder upside down. This way, the springs won't fall off the machine screws as you tighten them into the threaded inserts.



ftraee Plates

The brass plates on this level do more than provide a nice contrast with the walnut body. A cover plate protects the top vial, see margin. And two plates on the bottom reduce wear.

Note: We used l"-wide strips of brass. It's available at most hobby shops.

To fit the recesses cut earlier in the level, there's a gentle curve on the end of each plate. The trick is getting a perfect fit where the curved end meets the shoulder of the recess.

TEMPLATE. To do this, I made a template out of posterboard (see margin), then used it to lay out the curved ends on the brass.

FILE. Now it's just a matter of filing the ends to fit. What works well here is to set the file in a kerf in a scrap block, see photo A. Then pivot the brass back and forth, checking the fit frequently.

COUNTERSINKS. The next step is to drill countersinks for the screws that will be used to attach the plates, see Fig. 9,

After laying out the location of these holes, make a punch mark to keep the bit from wandering, see photo B. Then drill each countersink so the screw heads will be just a bit proud, see photo C. (They'll be sanded flush later.)

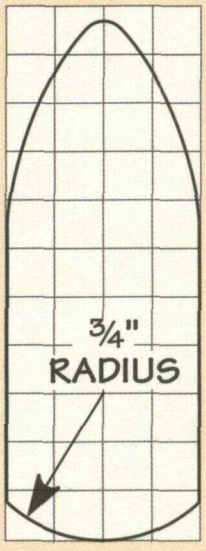
VIEW SLOT. In addition to the countersinks, there's also a "view slot" in the cover plate so you can see the bubble in the vial. Drilling non-overlapping holes and filing the edges smooth makes quick work of cutting this slot.

TAPER ENDS. Before attaching the wear plates, you'll want to taper the ends of the level. You can use the same template as before to lay out the basic shape. Then cut the ends to shape, see Fig. 10.

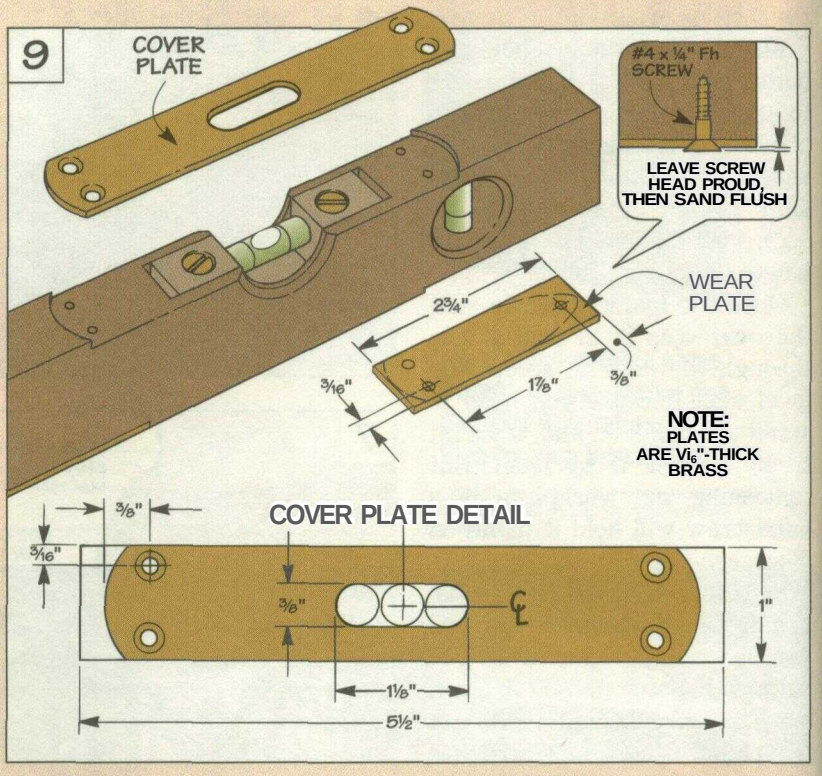
ATTACH WEAR PLATES. The wear plates also have to be shaped to match the ends of the level. But it's easiest to do this *after* you attach them to the level.

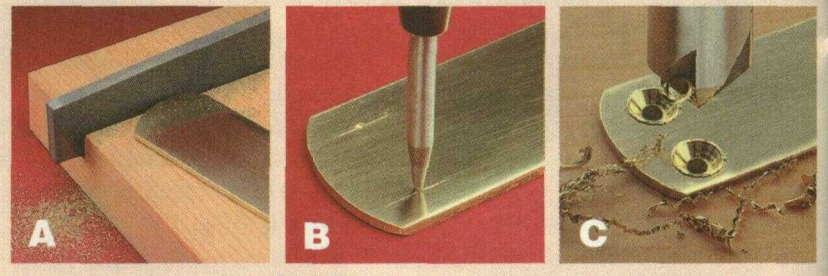
The plates are held in place with brass screws. The heads of these screws will need to be sanded flush with the plates. To do this, I attached 220-grit silicon-carbide sandpaper to a flat surface and sanded gently back and forth.

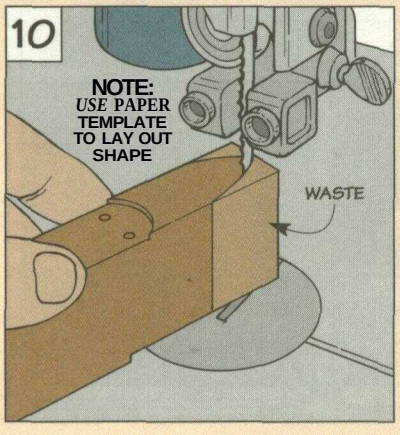
FILE & SAND PLATES. All that's left is to file the edges of the wear plates to shape, see Fig. 11. Then sand them flush with the level.

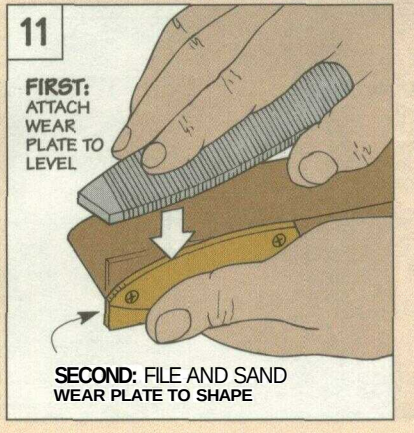


AL/se this full-size pattern to make a template of the curved ends of the plates as well as the torpedo shape of the level.

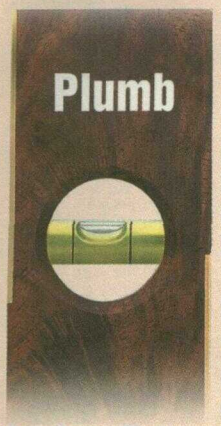








Adjusting the Level



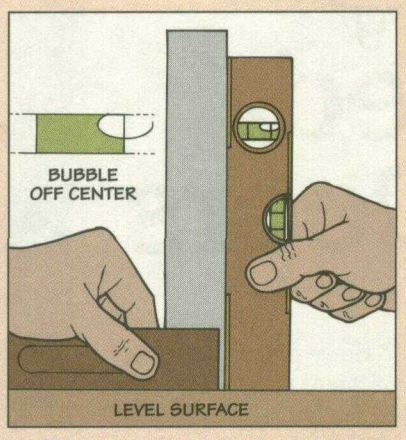
To get accurate results, the *plumb* vial needs to be perpendicular to the bottom edge of the level, see photo.

Since the hole for the vial was drilled at 90° to this edge, it should be close. But you may need to "true up" the bottom just a bit.

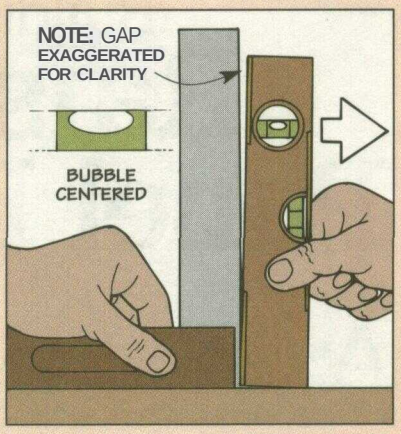
To find out, start with a *known* level surface. (For a tip on establishing this surface, refer to page 27.) Then check the plumb vial, see Step 1.

If it's not accurate, reposition the level until the air bubble in the vial is dead on, see Step 2. This will create a slight gap between the try square and one end of the level.

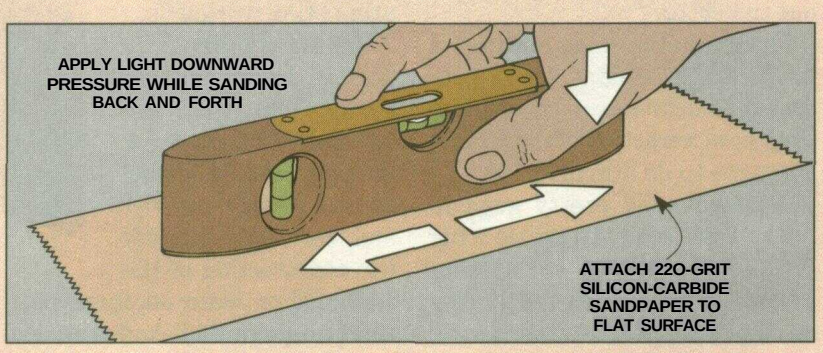
To true up the level, simply sand the *opposite* end, see Step 3. Just be sure to check the vial again every two or three strokes.



1 *To check the plumb vial, place the level against a try square that's on a known level surface.*



2 *Now move one end of the level away from the square until the air bubble is dead on.*

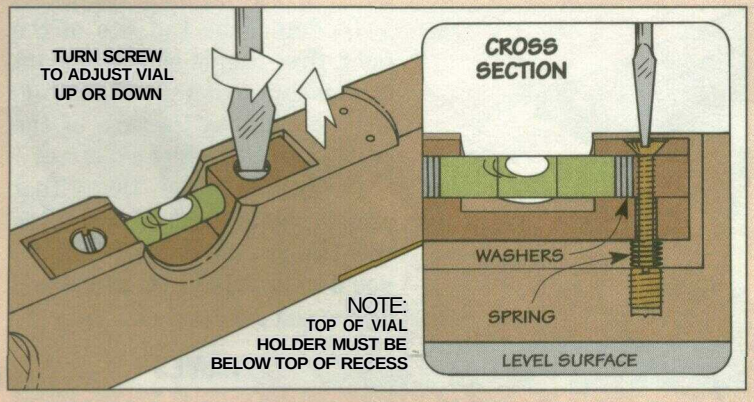


3 *If you need to true up the bottom of the level, attach a piece of sandpaper to a flat surface. Then with pressure on the end that needs to be shaved down, take two or three light strokes.*

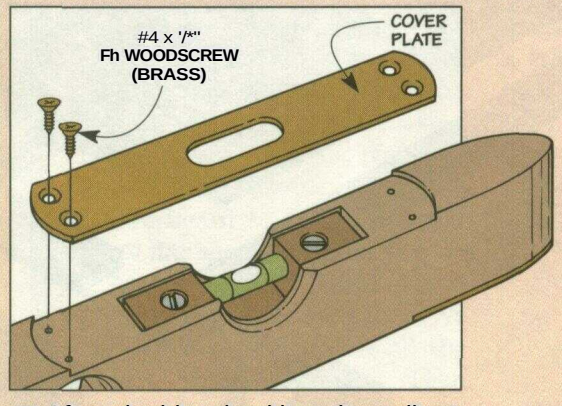
The second part of the adjustment process is to calibrate the *level* vial, see photo.

Here again, you'll need to use a known level surface to make a precise adjustment, see Step 4. After centering the air bubble in the vial, it's a good idea to double check the adjustment. To do this, turn the level end for end — the reading should be the same.

Once you're satisfied with the adjustment, simply attach the cover plate with screws, see Step 5. A.

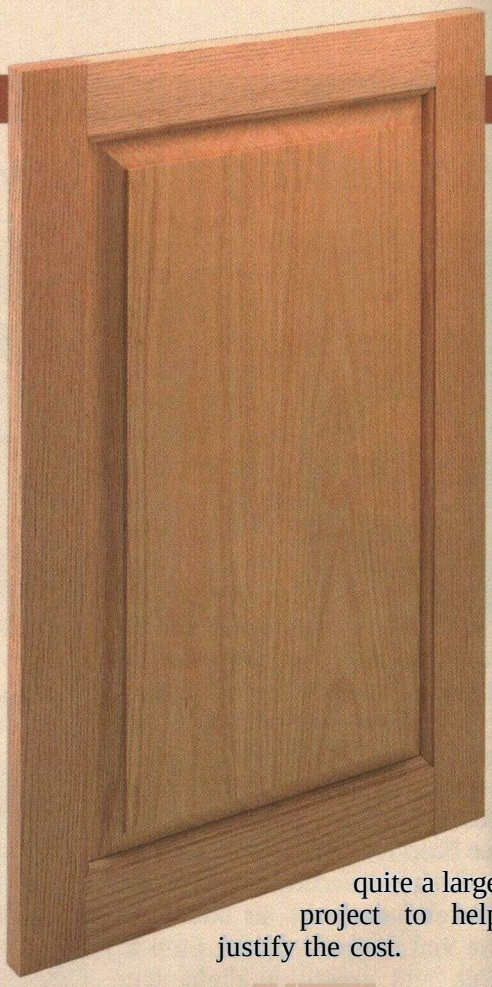


4 *With the level resting on a known level surface, adjust one end of the vial holder up or down until the air bubble is centered on the indicator lines of the vial.*



5 *After double checking the adjustment of the vial, the brass cover plate is simply screwed in place.*

Building Raised Panel Doors



To build raised panel doors like a pro, all you need is a router table and three special bits.

A few years ago, I had a chance to see several big, industrial woodworking machines. You know the type — the kind where you throw a log in one end and get a finished cabinet out the other.

Okay, so I'm exaggerating a bit. But the point is, these production machines can crank out a project in a fraction of the time it takes me to do it in my shop.

That sounded pretty good to me as I got ready to tackle a big project of my own — building raised panel doors for my kitchen cabinets.

Since there were a lot of doors to build (I was replacing twenty-three "slab" doors), I decided to temporarily convert my own shop into a production workshop.

SPECIALTY BITS. To do this, I bought *three* router bits that are specially designed for making raised panel doors. A pair of *stile* and *rail bits* simplify the construction of the frame. (For more on these bits, refer to page 24.) And a *raised panel bit* creates the profile around the edge of the solid wood panel, see page 15.

COST. Although these router bits make quick work of building a raised panel door, there is one drawback—they're fairly expensive. (I spent about $100 for the stile and rail bits and $70 for a raised panel bit.) So it takes quite a large project to help justify the cost.

PLANNING

Once you get the bits, it's tempting to get started right away. But a little planning now will save a lot of problems from cropping up later.

SIZE. First of all, you'll need to establish the overall *size* of each door. This depends on the type of door you're building.

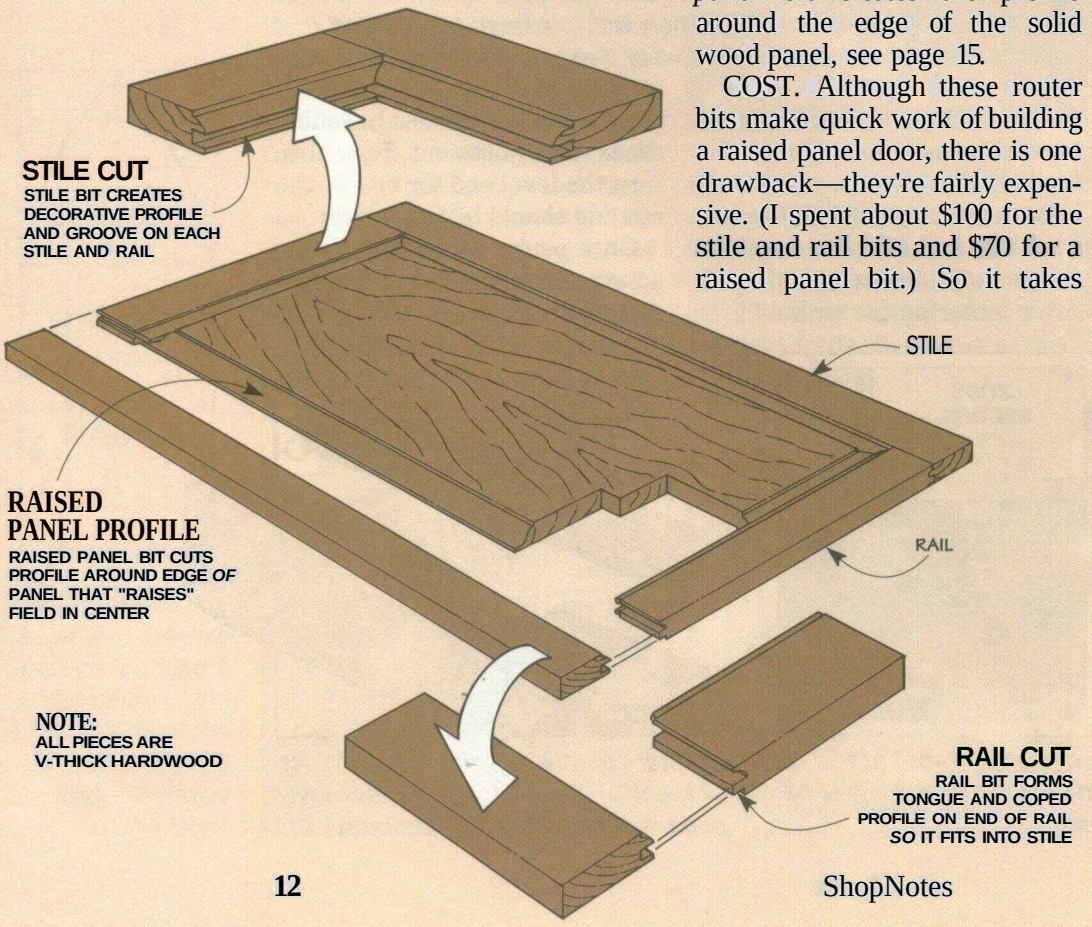
OVERLAY. One of the most common types is an *overlay* door. Like its name implies, it overlays the face frame of the cabinet, see drawing on next page.

To determine the size of the door, first decide on the amount of overlay you want. Then add that amount to the size of the opening in the cabinet.

HINGES. Another thing that affects the amount of overlay is the design of the hinges. So you'll want to have them on hand *before* you get started.

FRAMES

The first step in building the doors is to make the wood frames that wrap around the raised


STILE CUT
STILE BIT CREATES DECORATIVE PROFILE AND GROOVE ON EACH STILE AND RAIL
STILE
RAISED PANEL PROFILE
RAISED PANEL BIT CUTS PROFILE AROUND EDGE OF PANEL THAT "RAISES" FIELD IN CENTER
RAIL
NOTE:
ALL PIECES ARE V-THICK HARDWOOD
RAIL CUT
RAIL BIT FORMS TONGUE AND COPED PROFILE ON END OF RAIL SO IT FITS INTO STILE

panel. Each frame consists of two vertical pieces (stiles) and two horizontal pieces (rails).

THICKNESS. In most cases, the stiles and rails are somewhere between %" and 1" thick. (I used $^3/4$"-thick stock for mine.)

WIDTH. The width of the frame pieces is a matter of personal preference too. I ripped the frame pieces to a width of *2V.*

LENGTH. You'll also need to establish the length of the frame pieces. This is easy for the *stiles.* They're cut to length to match the desired height of the door. But figuring out the length of the rails is a bit trickier.

To do this, start with the desired width of the door and subtract the combined width of the stiles (4*fe*" in my case). Finally, add the combined length of the tongues that will be routed later on the ends of the rails. Note: To determine the length of the tongue, use the rail bit to rout the profile on the end of a scrap piece, refer to page 14.

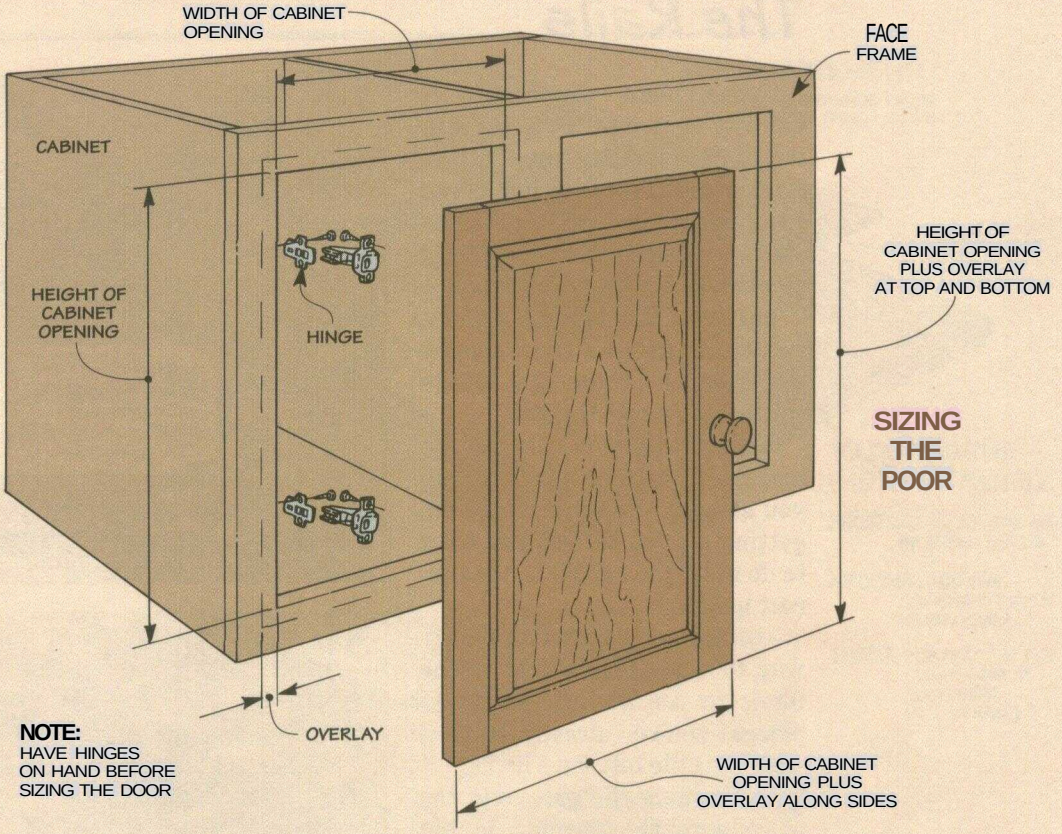
STILE BIT. After cutting all the stiles and rails to length, the next step is to use the stile bit to rout one edge on each piece. It forms a groove that accepts both the panel and the rail. At the same time, it creates the decorative profile around the inside edge of the frame.

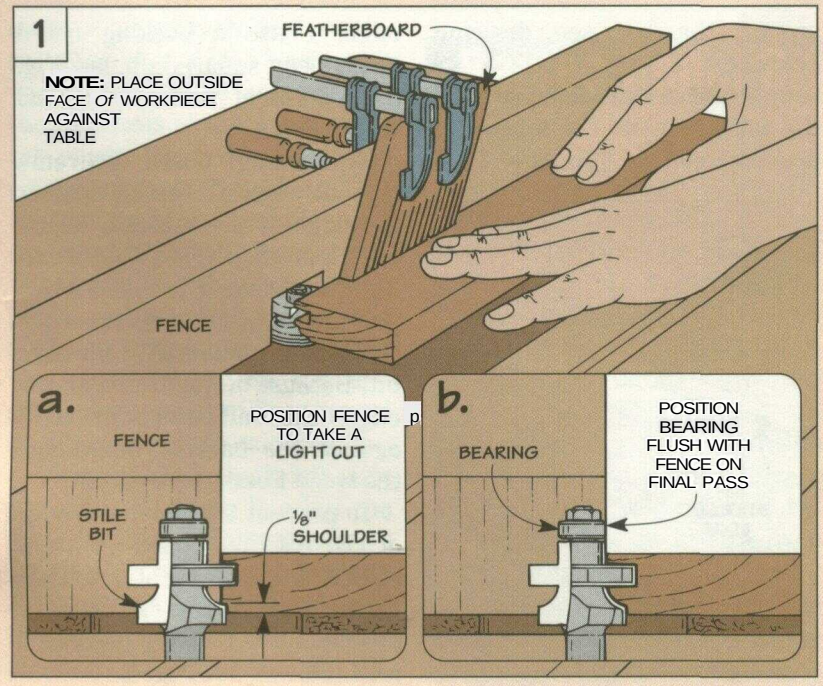
BIT HEIGHT. The shoulder of this profile provides a handy way to set the height of the bit. As a rule, I adjust the height so the bit leaves an Vs" shoulder, see Fig. la. If it's less than this, the shoulder tends to "disappear" when you look at it from across the kitchen.

FENCE. Once you've set the height of the bit, the next step is to position the fence. Why not just use the bearing on the bit to guide the frame piece? Because you'd be taking a full-depth cut. And removing that much material all at once could cause chipout on the edge of the piece.

So to provide a crisp, clean profile, set the fence to make a light cut, see Fig. la. Note: To ensure a consistent cut, use a featherboard to hold the workpiece flat against the table.

After routing each frame piece at one fence setting, move the fence back and run all the pieces through again. Then simply continue this process until the bearing is flush with the fence, see margin at right.





A *With a metal rule held on edge, it's easy to align the fence so it's flush with the bearing.*

The Rails

At this point the frame is halfway complete. But the rails won't fit the stiles yet. To produce a snug, square-shouldered joint where the rail meets the stile, you'll need to rout a mating profile on each end of the rails.

RAIL BIT. This is the job of the rail bit. It forms a short tongue and a coped profile that allows the rail to fit into the stile.

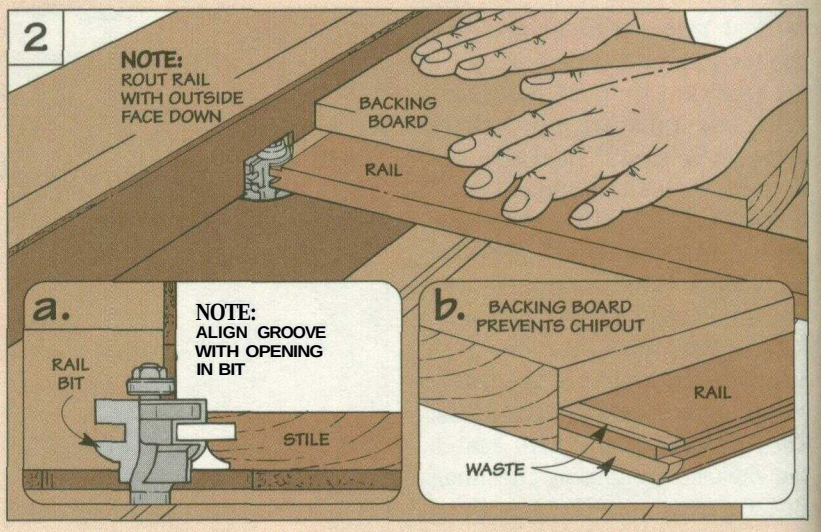
Since the rail and stile bits are machined to be a matched set, you shouldn't have any problem getting a good fit. All you have to do is set the rail bit to the correct height.

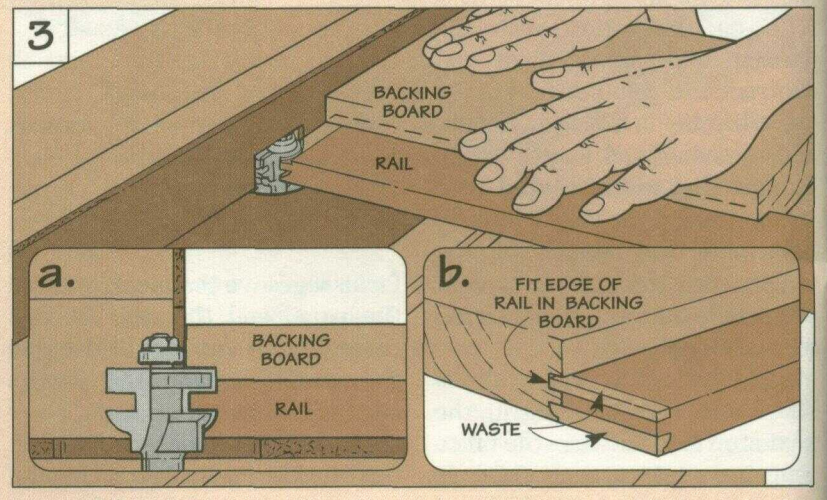
ADJUST BIT HEIGHT. An easy way to adjust the height of the bit is to use one of the workpieces you've already routed with the stile bit, see Fig. 2a.

By aligning the groove in the piece with the opening in the router bit, the top face of the rails and stiles should end up flush. (But you'll want to make a test cut anyway.)

Before routing the ends of the rails, there are a couple of things you can do to ensure a crisp, clean cut.

CLOSE FENCE OPENING. To keep the narrow end of the rail from accidentally catching on the opening in the fence, I "close" it with a piece of hardboard that's notched to fit around the bit, see drawing below left.

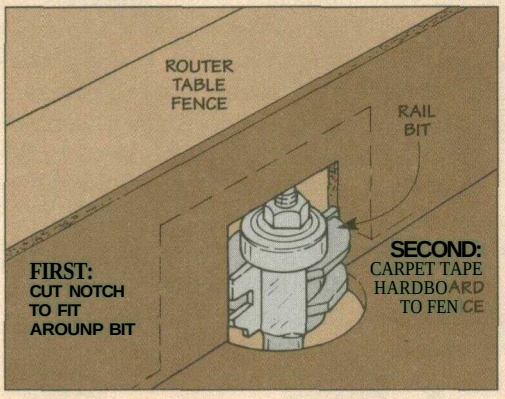




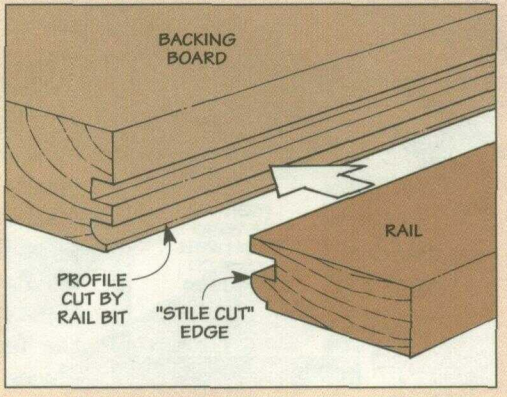
BACKING BOARD. Also, to keep the rail square to the fence and prevent chipout on the back edge, I use a backing board that's been squared up, see Fig. 2. (A chunk of "two by" material works fine.)

A backing board prevents chipout when it's resting against the edge of the rail that hasn't been routed yet, see Fig. 2 and 2b. But there's a problem when you use it to back up the edge that's been routed with the stile bit. Because of the profile on the edge, the rail won't fit tight against the backing board and the wood fibers can chip out.

To prevent this, rout one edge of the backing board with the rail bit, see drawing at left. Then fit the edge of the rail into the profile on the backing board and rout the end, see Fig. 3.



A *A piece ofhardboard with a notch to fit around the bit prevents the end of the rail from catching on the opening in the fence.*



A *To prevent chipout, use the rail bit to rout one edge of the backing board. Then fit the "stile cut" edge of the rail in the backing board.*

Raised Panel.

Now that the frame is complete, you can add the centerpiece of the door — a solid wood panel with a "raised" field in the center.

The panel is made by edge gluing several narrow pieces. As a rule, I use $^3/4^n$-thick stock and glue up the panel so it's longer and wider than the finished size.

SIZE. An easy way to determine this size is to first dry assemble the frame, see drawing. After measuring the opening in the frame, add the combined depth of the grooves. But don't cut the panel to that size just yet.

WOOD MOVEMENT. The thing to keep in mind is that the wood panel is going to expand and contract with changes in humidity.

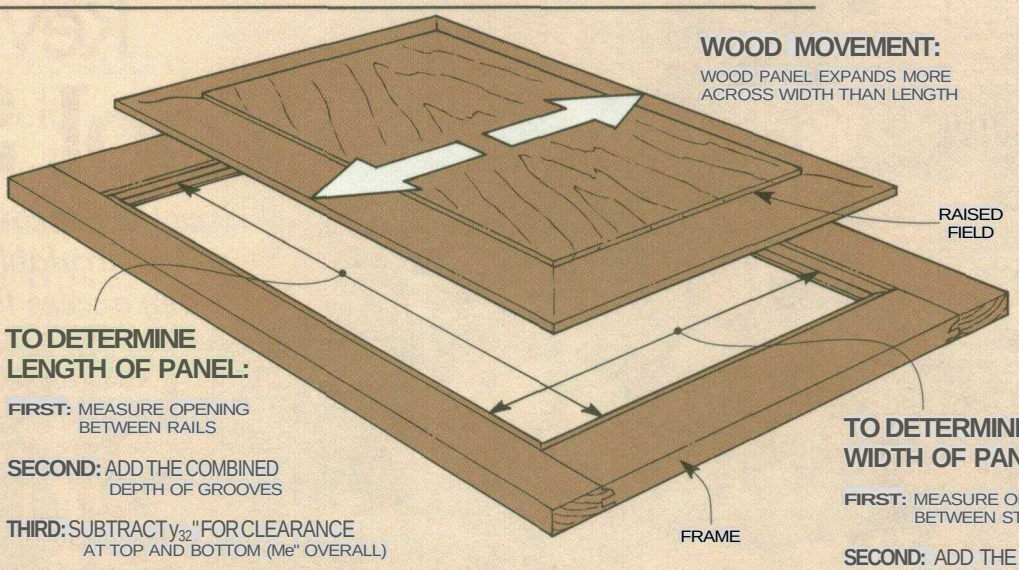
Most of this movement occurs across the *width* of the panel (not the length). So I allow for an Vs" clearance on each side (V/ overall). But a ^1kz clearance at the top and bottom is plenty.

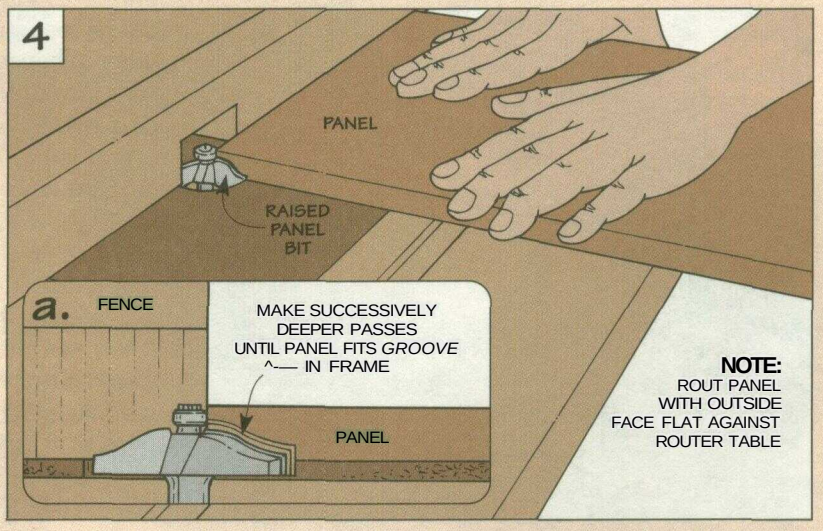
RAISED FIELD. Once the panel is cut to size, you're ready to "raise" the field in the center, see drawing. It's formed by routing a wide profile along each edge with a raised panel bit, see box.

The idea here is to make a series of successively deeper cuts, see Figs. 4 and 4a. Each pass widens the profile and reduces the thickness of the panel along the edges. By making multiple passes, you can "sneak up" on the final thickness until the panel fits snug (not tight) in the grooves.

To end up with a crisp, clean profile, it's best to rout the ends of the panel first, see Fig. 4. This way, any chipout on the end grain of the panel will be cleaned up when you rout the edges.

ASSEMBLY. All that's left is to assemble the door. To allow the panel to expand and contract, it's not glued into the frame. Instead, it "floats" inside. So after fitting the panel into the rails, simply glue the frame together. A


WOOD MOVEMENT:
WOOD PANEL EXPANDS MORE ACROSS WIDTH THAN LENGTH
RAISED FIELD
TO DETERMINE LENGTH OF PANEL:
FIRST: MEASURE OPENING BETWEEN RAILS
SECOND: ADD THE COMBINED DEPTH OF GROOVES
THIRD: SUBTRACT y32" FOR CLEARANCE AT TOP AND BOTTOM (Me" OVERALL)
FRAME
TO DETERMINE WIDTH OF PANEL:
FIRST: MEASURE OPENING BETWEEN STILES
SECOND: ADD THE COMBINED DEPTH OF GROOVES
THIRD: SUBTRACT Ve" FOR CLEARANCE AT EACH SIDE (V4" OVERALL)



Raised Panel Bits

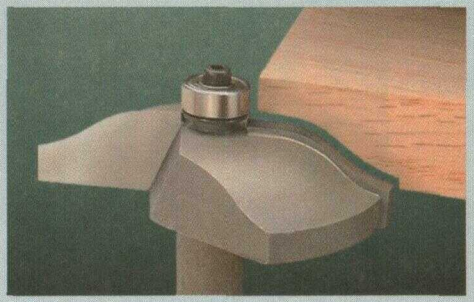
An easy way to create a "raised" field in the center of a solid wood panel is with a raised panel bit and a router table.

HOW THEY WORK. The basic idea of a raised panel bit is simple. The panel is held flat against the router table. As you slide it across the table, the cutting edges of the bit sweep across the face of the panel. This forms a wide profile that "raises" the field in the center.

SIZE. It's the width of this profile that explains the large size of these bits. (They can range in size from 2%" to 3V2[1]" in diameter). Because of their large size, the safest operating speed for the router is 12,000 rpms or less.

This requires a router with variable speed control. Also, since these bits all have V2"-dia. shanks, you'll need a router with a ^1lz collet.

Note: For sources of raised panel bits, refer to page 31.



Revolving Tool Station

Give the "carousel" on top a spin or rotate the turntable underneath to provide easy access to your power tools.

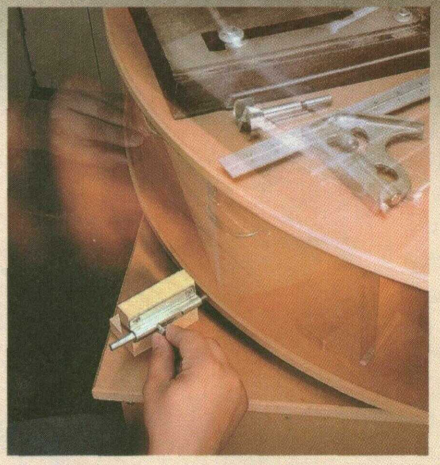
I've never met a woodworker yet who had too much space in his shop. Maybe that explains why we're always looking for ways to use the space that *is* available as efficiently as possible.

One of the most useful, space-saving ideas I've seen in awhile was sent in recently by *Robert Bunata* of Fort Worth, Texas. Basically, it's a rotating tool stand that provides easy access to a number of benchtop tools in a small amount of space.

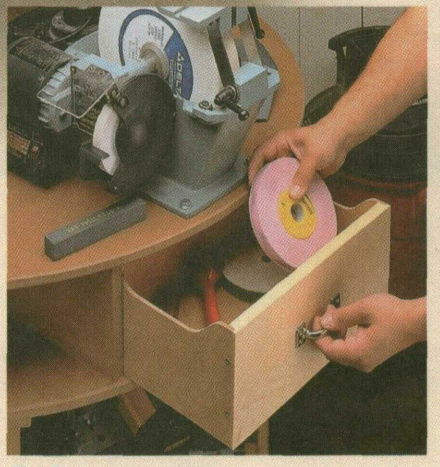
TOOL STATION. Using a similar idea, we decided to build a revolving tool station of our own, see photo. This station has a "footprint" that only takes up about nine square feet of space (we tucked ours in a corner). Yet it combines a work center *and* a storage area that would normally use up much more room.

WORK CENTER. The heart of the work center is a large circular platform that spins around like a carousel, see photo A below. Mounting your benchtop tools to this platform provides quick access to each tool while keeping the others close at hand.

STORAGE AREAS. Besides the convenient tool access, there's also plenty of storage. Directly under each tool is a drawer for storing accessories, see photo B. And a rotating turntable in the base provides storage for a number of portable power tools as well, see photo C.

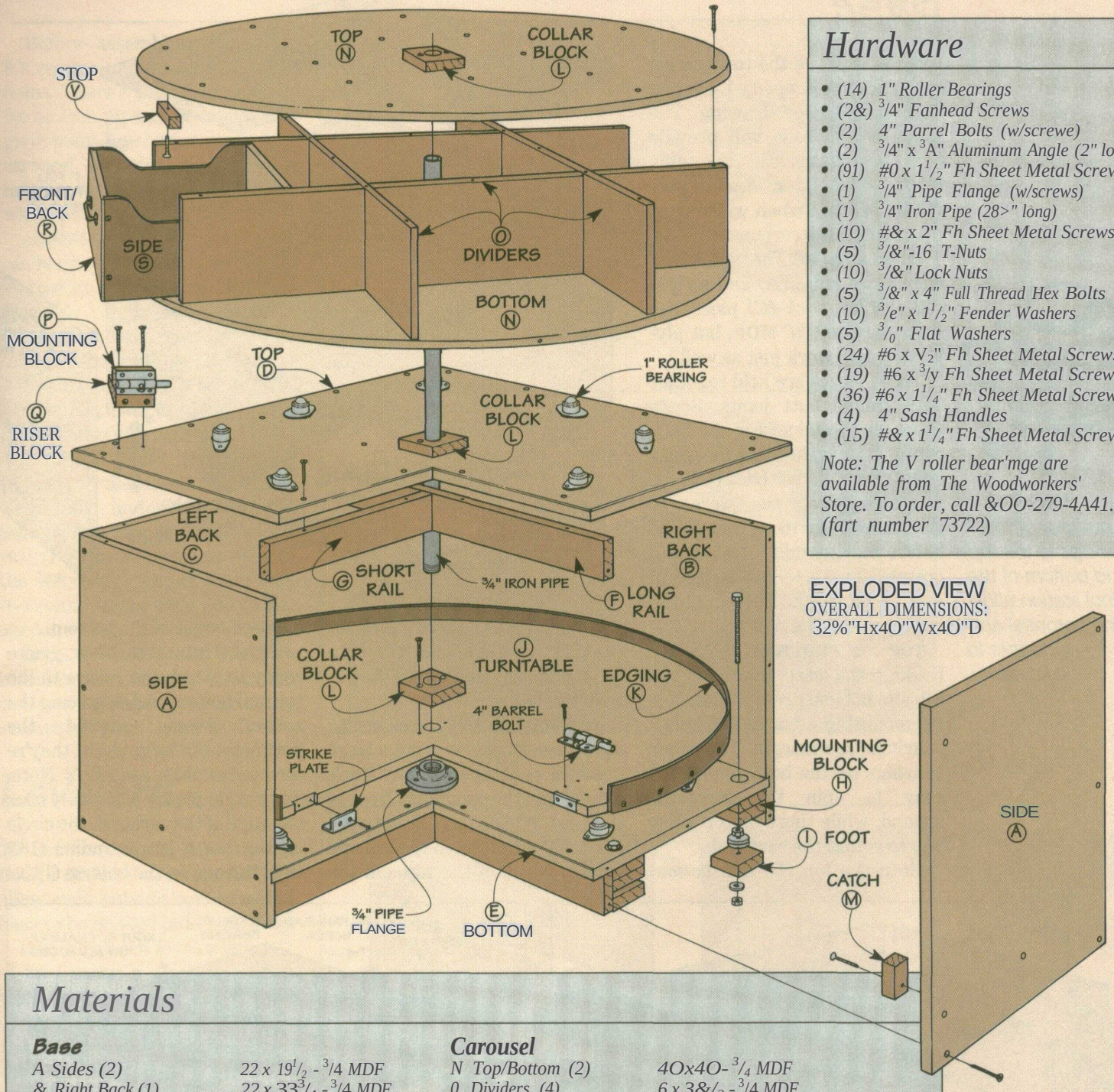


A. Carousel. Just spin the carousel to put the tool you need directly in front of you. Then lock it in place.



B. Drawers. With a drawer below each tool, there's plenty of storage for accessories and other items.

C. Turntable. A spin of the turntable in the base provides quick and easy access to portable power tools.



Hardware

- (14) 1" Roller Bearings
- (2&) 3/4" Fanhead Screws
- (2) 4" Parrel Bolts (w/screwe)
- (2) 3/4" x 3A" Aluminum Angle (2" long)
- (91) #0 x 1 1/2" Fh Sheet Metal Screws
- (1) 3/4" Pipe Flange (w/screws)
- (1) 3/4" Iron Pipe (28>" long)
- (10) #& x 2" Fh Sheet Metal Screws
- (5) 3/&"-16 T-Nuts
- (10) 3/&" Lock Nuts
- (5) 3/&" x 4" Full Thread Hex Bolts
- (10) 3/e" x 1 1/2" Fender Washers
- (5) 3/0" Flat Washers
- (24) #6 x V2" Fh Sheet Metal Screws
- (19) #6 x 3/y Fh Sheet Metal Screws
- (36) #6 x 1 1/4" Fh Sheet Metal Screws
- (4) 4" Sash Handles
- (15) #& x 1 1/4" Fh Sheet Metal Screws

Note: The V roller bear'mge are available from The Woodworkers' Store. To order, call &OO-279-4A41. (fart number 73722)

EXPLODED VIEW
OVERALL DIMENSIONS:
32%"Hx4O"Wx4O"D

Materials

Base

A Sides (2)	22 x 19 1/2 - 3/4 MDF
& Right Back (1)	22 x 33 3/4 - 3/4 MDF
C Left Back (1)	22x33-5/4MPF
V Top (1)	36x36-3/4 MDF
E Bottom (1)	S&b x33 3/4-3/4 MDF
F Long Rails (2)	3/4x3-33
G Short Rails (2)	3/4x3-15
H Mounting Blocks (10)	3/4x3-3
I Feet (5)	3/4x3-3

Turntable

J Turntable (1)	30x3O-3/4 MDF
K. Edging (1)	1 3/4x72 1/4-1/&Hdt>d.
L Collar Blocks (3)	3/4*3-3
M Catch (1)	3/4x1-3

Carousel

N Top/Bottom (2)	4Ox4O-3/4 MDF
0 Dividers (4)	6 x 3&/2 - 3/4 MDF
P Mounting Block (1)	3/4x1-3
Q Riser Block (1)	3/4x2'/2-3

Drawers

R Fronts/Backs (&)	3/4 x 5 7/8 - 14 1/8
S Sides (&)	5 7/8 x 9 7/8 - V4 Hdbd.
T Bottoms (4)	13 B/& x 9% - V4 Hdbd.
U Cleats (&)	1/2 x 1/2 - 8 7/8
V Stops (4)	3/4x'/2-2

Note: To build this project, you'll need 2'/2 sheets of 3/4"-thick Medium-Density Fiberboard (MDF), a half sheet of 'A" hardboard, and approximately 1O bd. ft. of 3/4"-thick hardwood.

Base

Mounting a number of roller bearings to the top and bottom of the tool station allow the carousel and turntable to spin easily.

I began work on the tool station by making an open, L-shaped base cabinet, see drawing. The shape of the base will provide easy access to the turntable that's added later. And it provides leg room when working at the tools on the carousel.

SIDES & BACKS. The base starts out as two *sides (A)* and a *right (B)* and *left back (C)* piece, see Fig. 1. (I used $^3/_4$" MDF, but plywood would work just as well.)

These pieces are held together with simple butt joints. So to allow for the joinery in the back corner, the right back is wider ($33^3/_4$") than the left back (33").

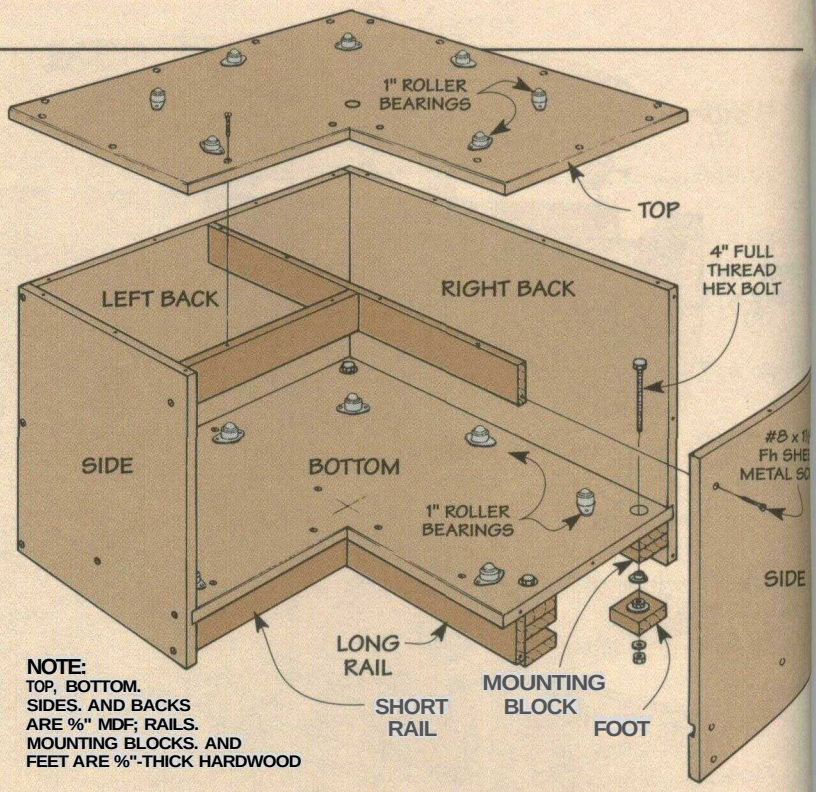
After cutting the pieces to size, there's one more thing to do before moving on to the top and bottom. That's to cut a dado in each piece for the bottom of the base, see Fig. la.

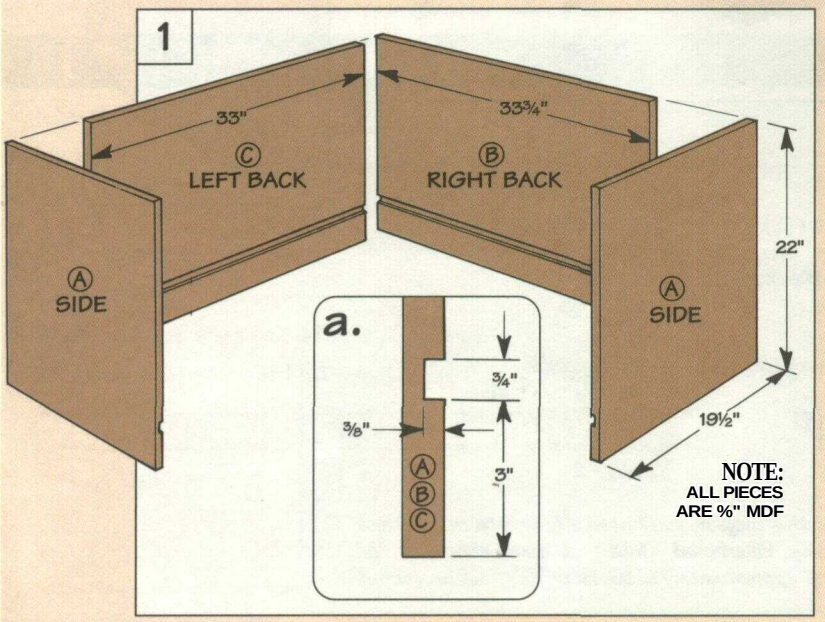
TOP & BOTTOM. Besides holding the case together, the top and bottom provide a surface for mounting a number of roller bearings, see margin. The roller bearings on the bottom make it easy to spin the turntable around, while those on top allow you to rotate the carousel.

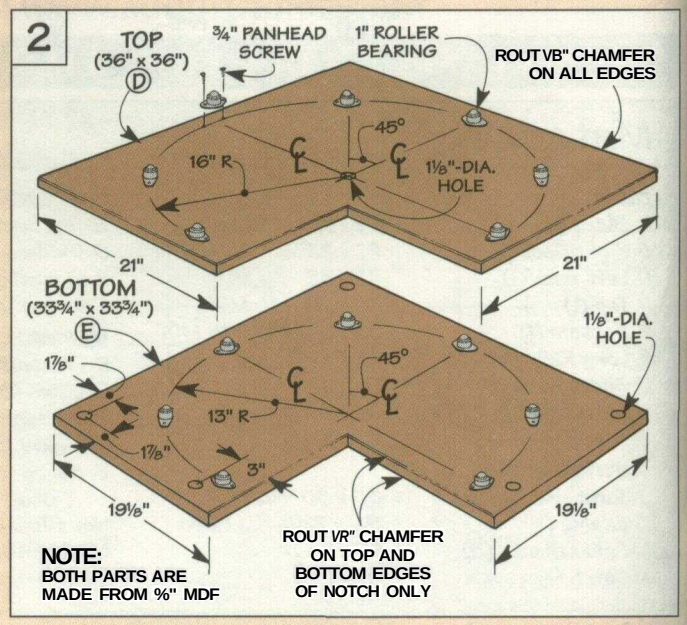
Both the *top (D)* and *bottom (E)* start out as a square piece of ^{3}/j" MDF, see Fig 2. But to create an overhang, the top is *larger* than the bottom.

NOTCH. With the pieces cut to size, the next step is to cut a large notch in each one so they don't extend into the opening in front of the base. While you're at it, rout a small (Vs") chamfer on the top and bottom edges of the top and the exposed edges of the bottom.

ATTACH ROLLERS. Now you're ready to attach the rollers to the top and bottom. After spacing the rollers evenly around the perimeter of a large circle, they're screwed in place, see Fig. 2. Note: To provide plenty of support near the edge of the carousel, the circle on top has a larger radius (16") than the one on the bottom (13").







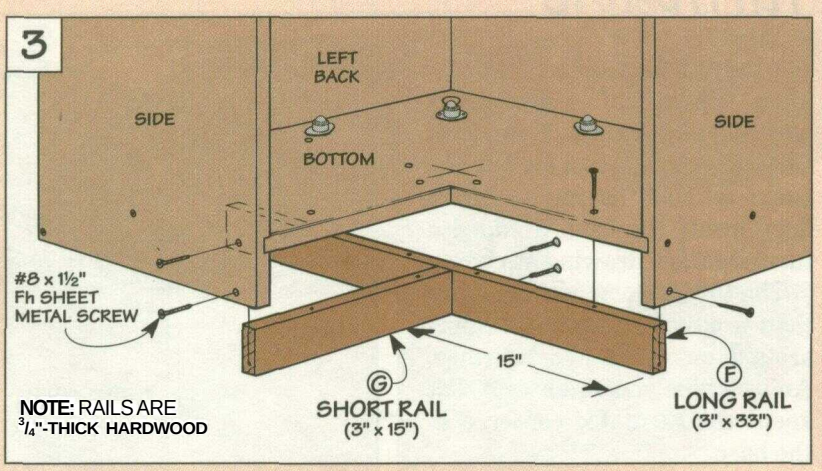
Before assembling the base it's easiest to drill several large holes. There's a hole in the top for an iron pipe that serves as a pivot point for the turntable and carousel, see Fig. 2. Also, five holes in the bottom will be used when levelers are added later.

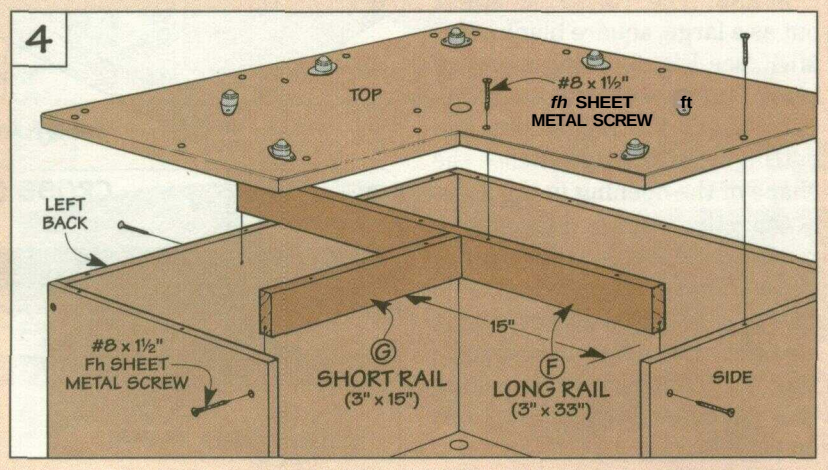
ASSEMBLY. At this point, you can begin assembling the base. I started by gluing up a U-shaped assembly consisting of one side and the two back pieces.

Then I slipped the bottom in place and added the other side. Reinforcing each joint with screws helps strengthen the base.

RAILS. To add even more rigidity, I installed two hardwood rails under the top and bottom, see Figs. 3 and 4. A *long rail (F)* spans from one side to the left back. And a *short rail (G)* connects the long one to the opposite side.

ATTACH TOE All that's left to complete the base is to attach the top. It's simply glued and screwed in place, see Fig. 4.



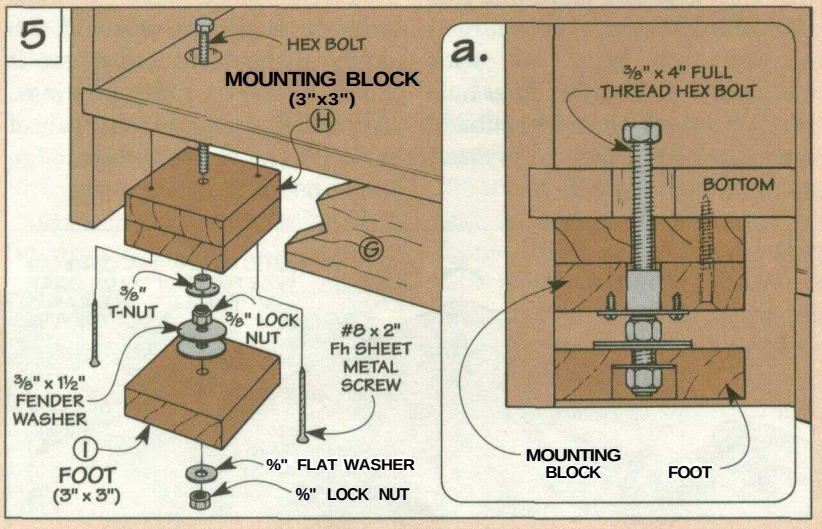


Levelere

To compensate for an uneven floor, I added five levelers. They allow each outside corner of the base to be leveled independently.

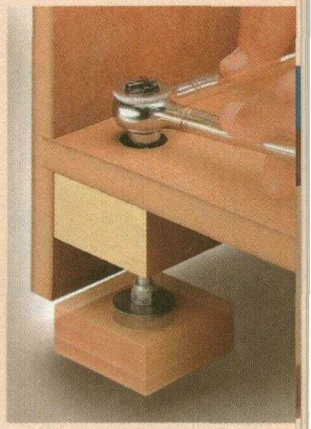
Basically, each leveler consists of two parts: a thick mounting block that attaches to the bottom of the base and an adjustable foot, see Fig. 5. By turning a bolt that passes through the center of each part, you can raise or lower the foot, see margin.

MOUNTING BLOCK. To provide plenty of strength, each *mounting block (H)* is made by gluing up two pieces of ¾"-thick hardwood (maple), see Fig 5. Before gluing and screwing the mounting block to the bottom of the base, you'll need to drill a counterbored shank hole for a T-nut that accepts the adjustment bolt, see Fig. 5a.



- FOOT. Once the block is in place, you can add the *foot (I).* It's a piece of ¾"-thick hardwood that's captured on the end of the bolt by a pair of lock nuts.

One nut rests in a counterbored shank hole drilled in the bottom of the foot. The other tightens against the top of the foot to lock it in place.



To raise or lower a leveler, simply turn the adjustment bolt with a socket wrench.

Turntable

A length of iron pipe threaded into a pipe flange works as a simple pivot for the turntable.

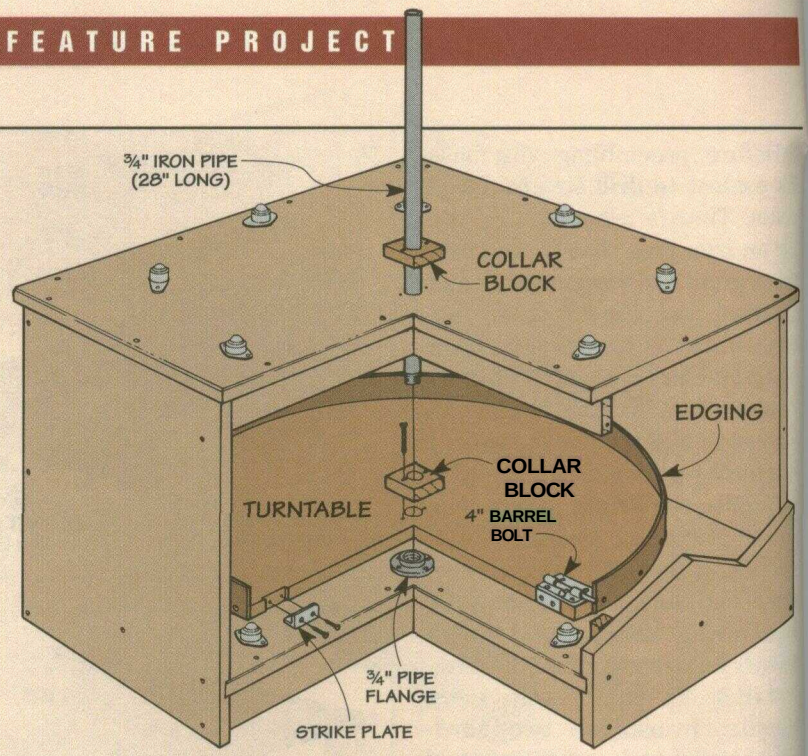
The base of the tool carousel provides plenty of storage for portable power tools. To make it easy to remove a tool (or put one back) without having to reach deep inside the base, I added a turntable, see drawing at right.

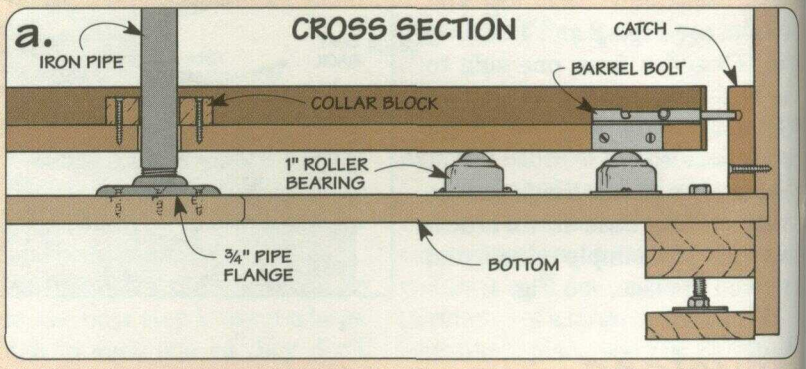
The turntable is nothing more than a circular shelf that spins around on the roller bearings. An iron pipe acts as an axle that keeps the turntable centered in the base.

BLANK. The turntable starts out as a large, square blank of ¾" MDF, see Fig. 6. Using a square blank provides straight reference edges for laying out and cutting a notch that matches the shape of the opening in the base.

Once the notch is done, you're ready to cut the *turntable (J)* to its final shape. An easy way to do this is to mount a router with a straight bit to a simple circle cutting jig. (For more on making this jig, refer to Shop Solutions on page 27.)

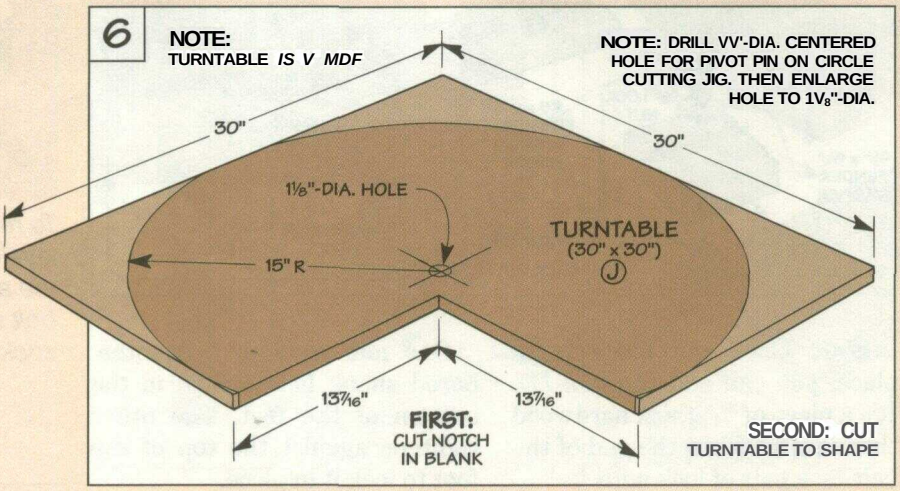
To use the circle cutting jig, you'll need to drill a small (centered) hole in the turntable for a bolt that acts as a pivot pin. But this hole will need to be enlarged so the iron pipe can stick through. I drilled this final hole slightly larger than the outside diameter of the pipe to prevent wear on the turntable.

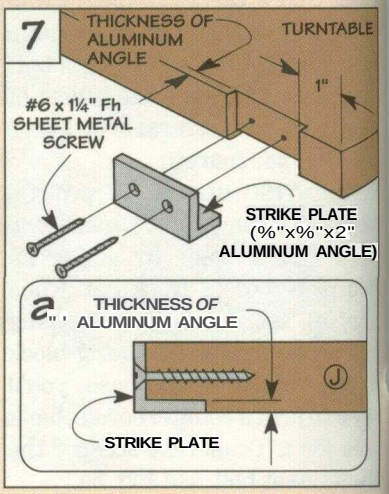




Another place that could wear a bit is along the edge of the notch in the turntable where it rides up on the roller bearings. To prevent this, I added a pair of metal strike plates to each edge of the notch.

STRIKE PLATES. These strike plates are quite simple — just short pieces of aluminum angle. They fit in shallow mortises in both the front edge and bottom of the turntable, see Fig. 7. After laying out the location of the





mortises, just remove the waste material with a chisel.

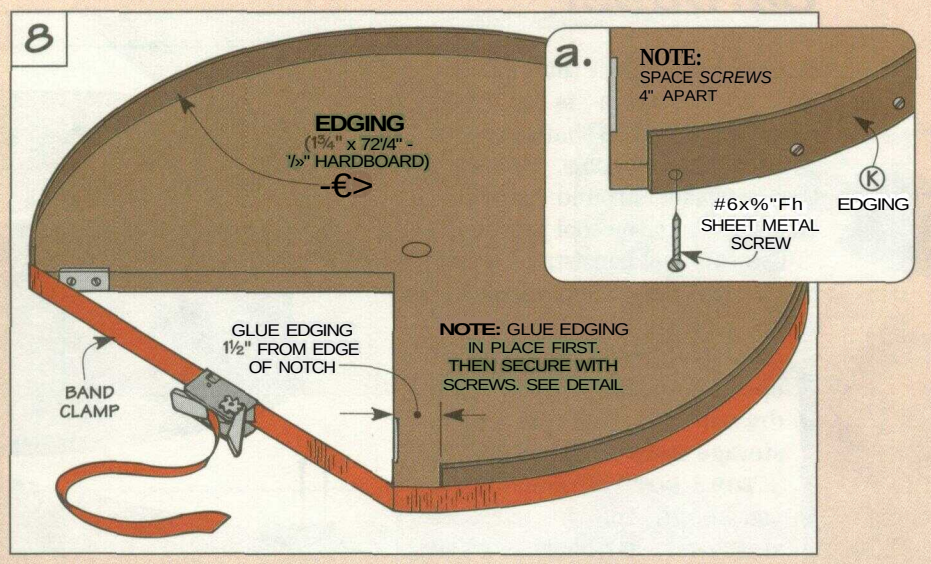
EDGING. Once the strike plates are screwed in place, the next step is to wrap a thin (Vs") strip of hardboard *edging (K)* around the curved part of the turntable. The edging is taller (wider) than the thickness of the turntable. This way, it forms a lip that keeps tools and materials from falling off the edge of the turntable.

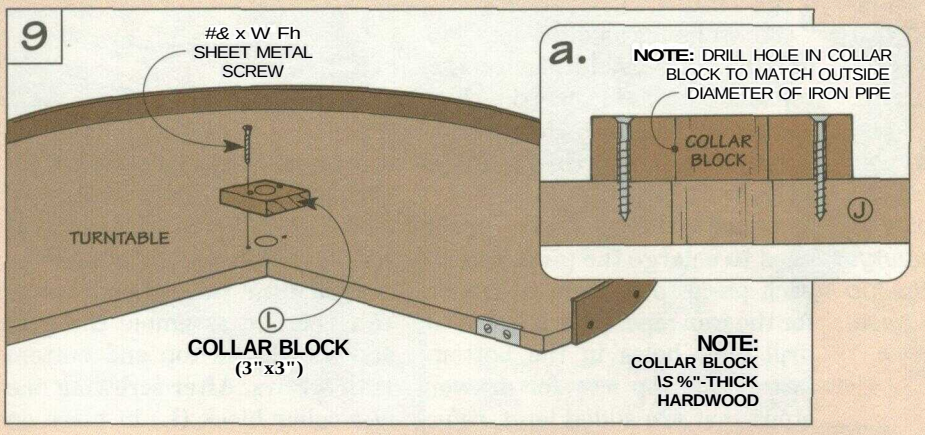
One thing to notice about the edging is it's 1V2" *shorter* than the distance around the turntable, see Figs. 8 and 8a. This provides clearance for a barrel bolt that's used later to lock the turntable in place, refer to drawing on opposite page and Fig. 10.

All it takes to attach the edging is to apply a little glue and hold it in place with a band clamp. After the glue dries and you remove the clamp, it's a good idea to secure the edging with screws, see Fig. 8a.

COLLAR BLOCK. At this point, you're almost ready to install the turntable. But first, to prevent it from rubbing against the pipe, I added a collar block, see Fig. 9.

The *collar block (L)* is a $^3/_4$"-thick piece of hardwood with a centered hole that's sized to fit the iron pipe. Note: For a tip on drilling this hole so the collar block fits snug around the pipe, refer to page 27.

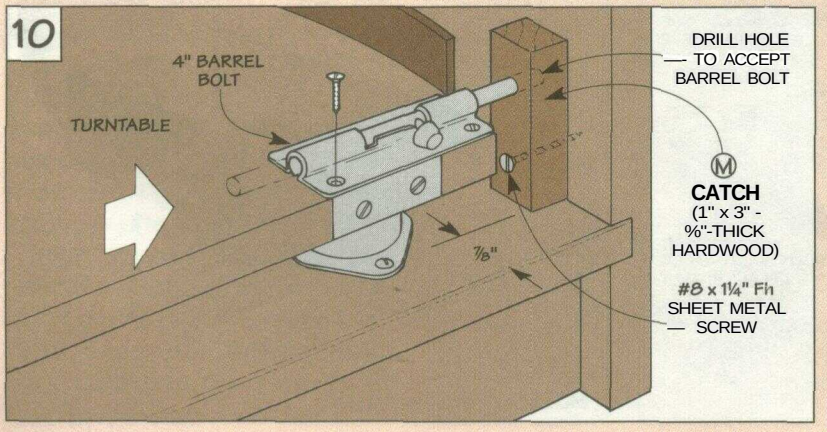




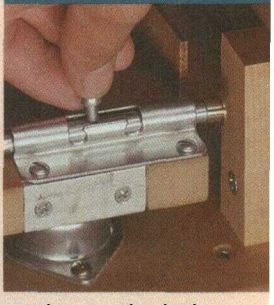
PIPE. After screwing the collar block in place, you can turn your attention to the pipe that staves as a pivot point for the turntable, see drawing on page 20. (I used a piece of *V* iron pipe.) The pipe fits into a flange screwed to the bottom of the base, see detail 'a' in drawing. Note: The pipe is extra long so it can double as a pivot point for the carousel that's added later.

Before installing the pipe, you'll need to set the turntable in place. Then slip the pipe through the top of the base and turntable and thread the end into the flange. Here again, to keep the pipe from rubbing, I screwed a second collar block (L) to the top of the base, see drawing on opposite page.

BARREL BOLT. Finally, to lock the turntable in place, I added a barrel bolt, see Fig. 10. The bolt slides into a hardwood *catch (M)* attached to the side of the base. After gluing and screwing the catch in place, I located and drilled a hole in the catch to accept the end of the barrel bolt, see margin.

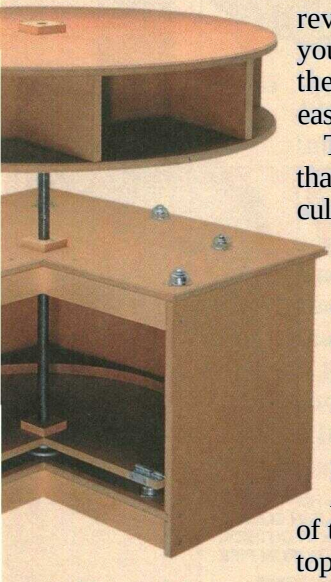


Shop Tip



To locate the hole for the barrel bolt, slip a dowel center over the end of the bolt and press it against the wood catch.

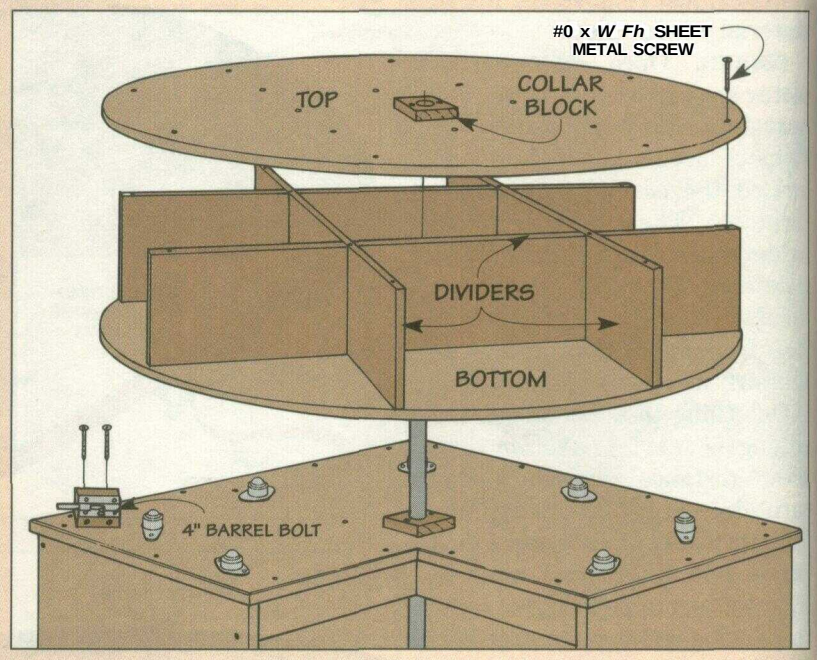
Carouael.



To provide easy access to your benchtop tools, the carousel spins on the roller bearings attached to the top of the base.

One of the handiest things about this tool station is a large revolving carousel that supports your benchtop tools. Spinning the carousel around provides easy access to the tool you need.

The carousel consists of a grid that's sandwiched between a circular top and bottom, see drawing at right. The grid creates an opening under each tool for a drawer as well as small storage areas on the sides.



TOP & BOTTOM. The *top* and *bottom (N)* of the carousel start out as large square pieces of ¾" MDF, see Fig. 11. After laying out the location of the screws used to fasten the top and bottom to the grid, they can be cut to shape. Here again, a router and a circle jig make quick work of this.

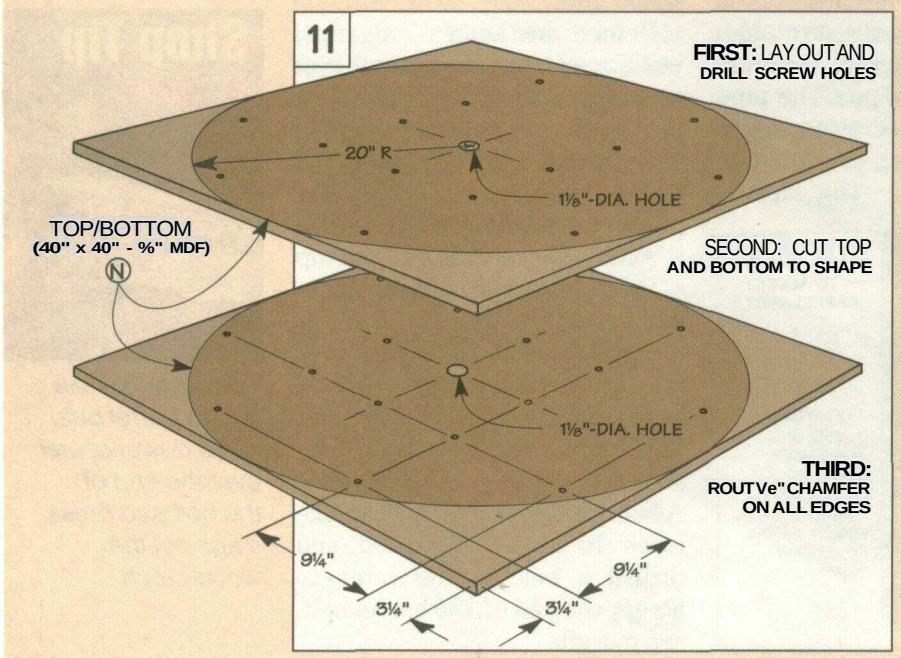
As with the turntable, you'll need to enlarge the pivot hole in each piece to provide clearance for the iron pipe. Also, it's best to drill pilot holes in the bottom face of the top now for drawer stops that are added later, refer to Figs. 14 and 14a.

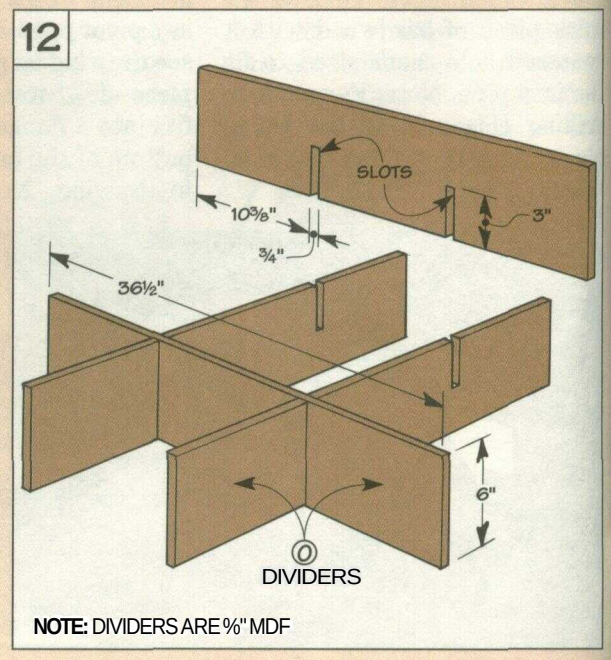
GRID. Now you can turn your attention to the grid that divides the carousel into separate compartments. The grid consists of four *dividers (0)* with interlocking slots in each one, see Fig. 12.

ASSEMBLY. Once the slots are cut, you can assemble the grid and attach the top and bottom with screws. After screwing one last collar block (L) in place on the top, just get a friend to help you lift the carousel onto the base, see margin.

BARREL BOLT. To lock the carousel in place when using a tool, another barrel bolt is attached to the base, see Fig. 13. This bolt slides into holes drilled in the bottom edge of the carousel.

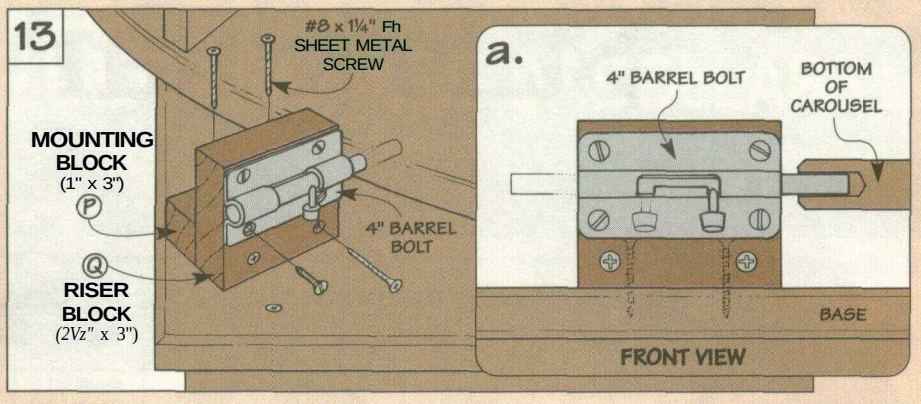
To raise the barrel bolt off the base so it aligns with the carousel, I added an L-shaped mounting assembly, see Fig. 13. It's made up of two small pieces of ¾"-thick hardwood: a *mounting block (P)*





that's screwed to the base and a riser 6Z0cA; *(Q)* that positions the barrel bolt in line with the bottom edge of the carousel, see Fig. 13a.

MOUNT TOOLS. Before drilling the holes, you'll want to mount your tools. (I used lag screws.) This way, you can rotate the carousel to the most comfortable working position for each tool. Then drill the holes at the correct locations.



Drawere

With the carousel complete, I added a set of four drawers. These drawers fit the openings directly below each tool to keep accessories right at hand where you need them.

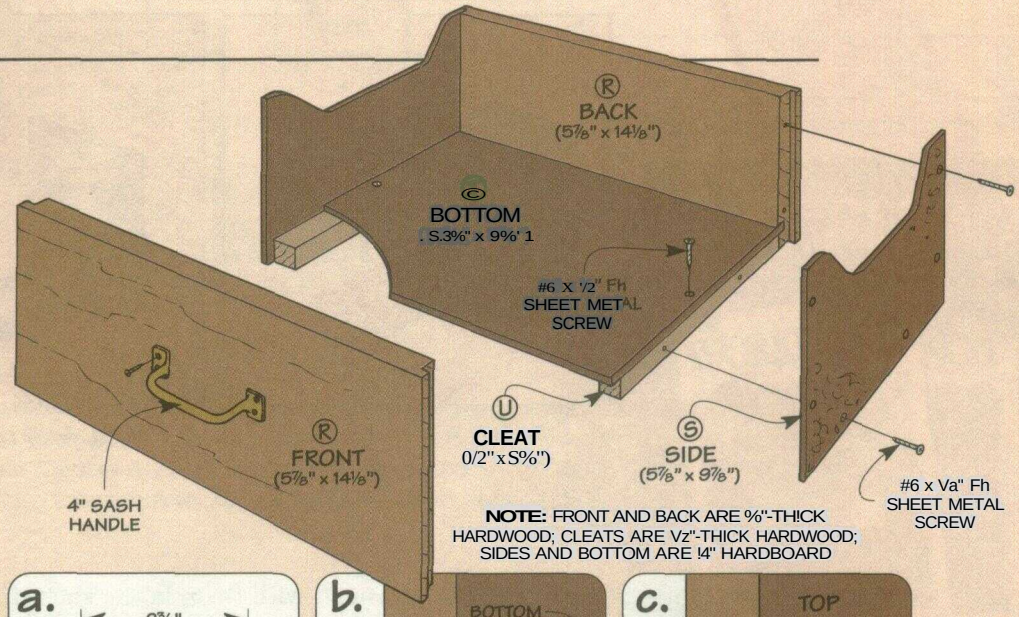
FRONT & BACK. To build the drawers, start by cutting *& front* and *back (R)* for each one. These are $^{3}/4^{n}$-thick pieces of hardwood sized to allow an Vg" gap along the sides and top of the opening.

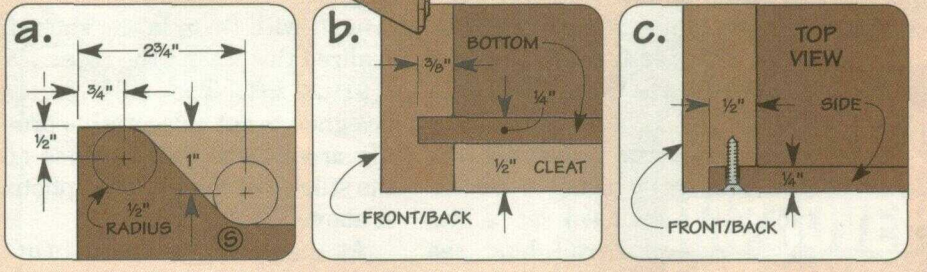
Shallow rabbets in the ends accept the sides of the drawer, see drawing and detail *c.' And there's a groove in each piece for the drawer bottom, see detail 'b.'

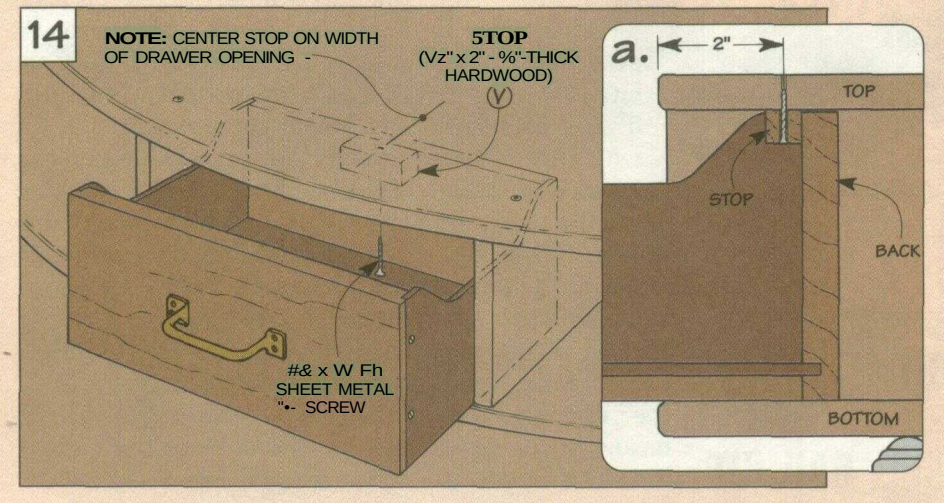
SIDES. After completing the front and back, you can add the *sides (S).* These are pieces of V/ hardboard with a notch at the top, see detail 'a.' When the drawer stops are added later, this notch makes it possible to remove a drawer and put it back in.

BOTTOM & CLEATS. There are just two things left to do to complete each drawer. A hardboard *bottom (T)* is cut to fit so the drawer can be glued and screwed together. And gluing two hardwood *cleats (U)* to the bottom and sides provides extra support.

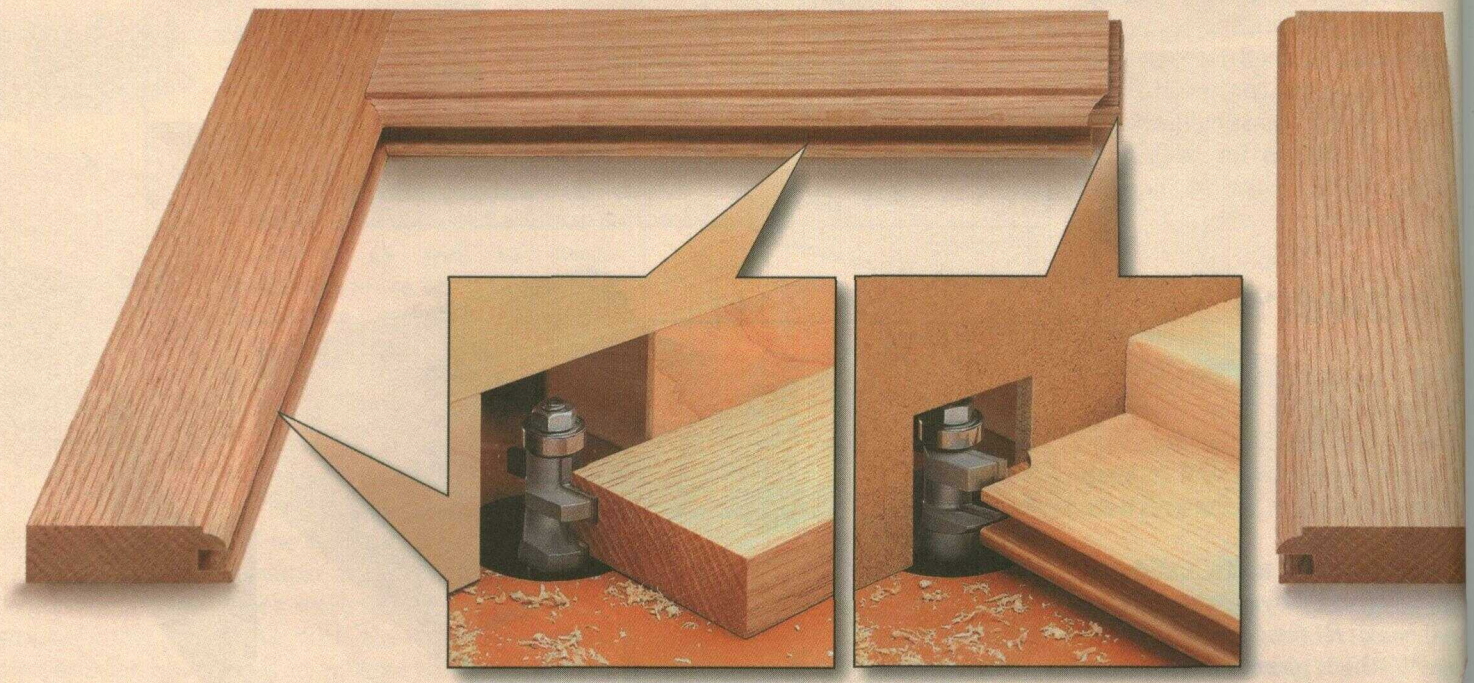
STOP Before installing the drawers, I attached four *stops (V)* under the top of the carousel. They keep the drawer from being pulled out too far and accidentally spilling what's inside. &


R BACK (5⅞" x 14⅛")
C BOTTOM (5.3⅜" x 9⅜' 1
#6 X '/2" Fh SHEET METAL SCREW
U CLEAT 0/2" x S⅝")
S SIDE (5⅞" x 9⅞")
#6 x Va" Fh SHEET METAL SCREW
R FRONT (5⅞" x 14⅛")
4" SASH HANDLE
NOTE: FRONT AND BACK ARE %"-THICK HARDWOOD; CLEATS ARE Vz"-THICK HARDWOOD; SIDES AND BOTTOM ARE !4" HARDBOARD





Stale & Rail Bits



A. Stile Bit. A stile bit creates a decorative profile and a groove on the edge of a stile and a rail.

B. Rail Bit. A rail bit forms a tongue and a coped profile on the end of a rail so it can fit into the stile.

In a commercial cabinet shop, the stiles and rails of a raised panel door are usually cut on a shaper. But if you don't have a shaper, you can accomplish the same thing by using a router table and a matched set of bits called stile and rail bits, see photo at left.

The first time I ever saw these bits, I was a little confused why one was called a stile bit and the other a rail bit.

Naturally, I just assumed that the stile bit was meant to cut stiles, and the rail bit was meant to cut rails. But after fiddling around with them in the shop, I realized this wasn't the case.

STILE **BIT.** The stile bit is designed to cut a decorative profile around the *inside edges* of the stiles *and* the rails, see photo A above.

At the same time as it's cutting this profile, the stile bit also forms a groove. This groove accepts the panel of the door as well as a tongue that will be cut on the ends of the rails.

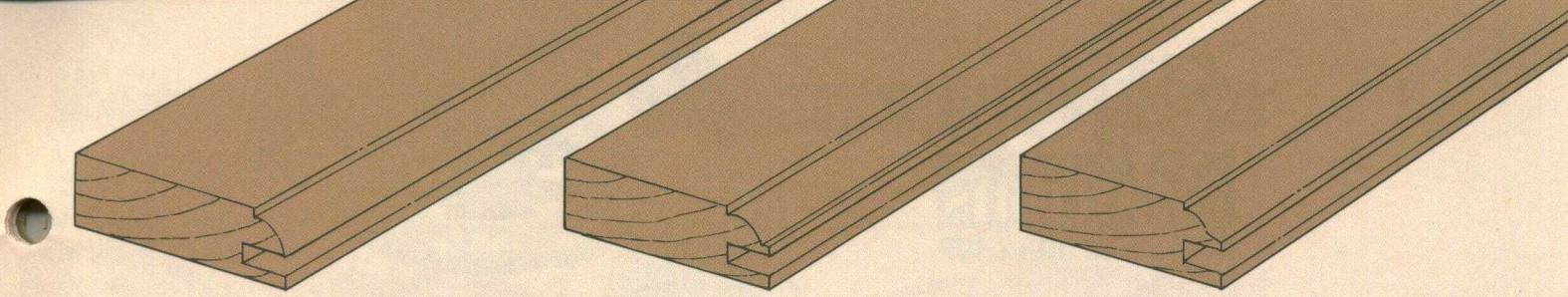
After the frame is assembled, the decorative profile and the groove both must run around the entire inside edge of the frame. If they don't, the molded edges of the rails and stiles won't match, and you won't be able to insert the raised panel.

So what's the confusion? To end up with a decorative profile and a groove along the entire inside edge of the frame, you have to use the stile bit to cutl both the stiles *and* the rails. In other words, the rails must be "stile cut" on the inside edges.

RAIL BIT. The rail bit is more aptly named. It's used only for cuts made on the *end grain* of the rails, see photo B.

The rail bit forms a short tongue that fits in the grooves formed by the stile bit. Along with the groove, it cuts a coped profile of the decorative edge that was formed by the stile bit. This way, when you assemble the pieces of the frame, it forms a tight-fitting joint.

PROFILES. Depending on the type of look you want around the inside edges of the frame, you can get stile and rail bits that will cut a number of different profiles. Three of the most



ROUNDOVER BEAD OGEE

common types of profiles are shown in the drawings above.

But there's more to choosing a set of stile and rail bits than selecting the profile. In fact, you may not want to get a set of bits at all. Let me explain.

INDIVIDUAL BITS. There are also *individual* bits available that are designed to make both stile *and* rail cuts. While these bits accomplish the same thing, they go about it in different ways, see boxes at right.

SHANK SIZE. Regardless of the type of bit, one thing to keep in mind is the size of the shank. Typically, stile and rail bits are only available with a V2"-dia. shank. So in most cases, you'll need a router with a collet that accepts *lz* bits.

The only exception is a set of matched stile and rail bits with y/ shanks that are manufactured by Freud. (Currently, these bits are only available with the roundover profile.)

No matter what size shank you get, the body of the bit that supports the cutting edge is pretty beefy. So as with any large bit, the speed of the router plays an important part in the performance of the bit.

ROUTER SPEED. What I've found works best is to run the router at a relatively slow speed (about 10,000-12,000 rpm). This not only provides a safer cut, but it also reduces the chance of the bit burning the wood — especially when using the rail bit to cut end grain.

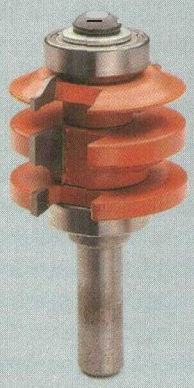
The only drawback to running the bits at a slow speed is you'll need a router with variable speed control. (Or you can get a separate speed control for a single-speed router.)

SOURCES. Stile and rail bits are available in many woodworking stores and catalogs, refer to Sources on page 31. At first, the price of these bits may seem a bit steep (they range in price from $60 to $130). But if you're building a number of doors, they're worth the cost. A

Combination Bit

This combination stile and rail bit has one big advantage over a matched set of bits — you don't need to switch bits between cuts.

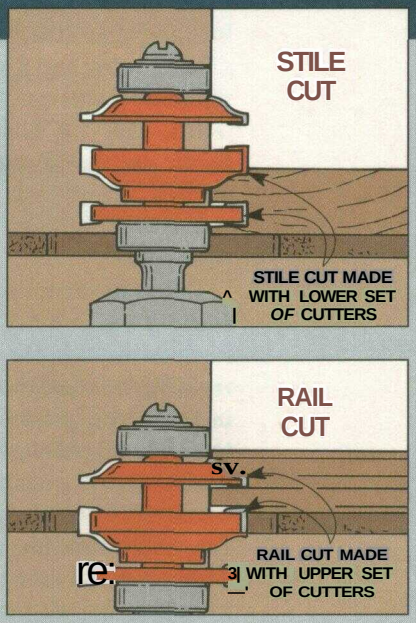
That's because the parts of the bit that make the stile cut and the rail cut are both stacked on a single shank.



To make a stile cut, you raise the bit and use the cutters on the lower part of the bit, see top drawing.

Simply lowering the bit and using the cutters on the top part of the bit allows you to make the rail cut, see bottom drawing.

Note: A source for this bit is listed on page 31.



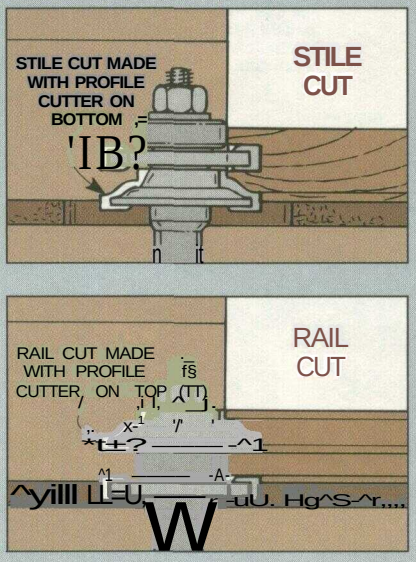
Reversible Bit

A reversible stile and rail bit also combines both cutters on a single shank. But that's where the similarity ends.

To switch from the stile cut (top drawing) to the rail cut (bottom), you have to disassemble the bit and swap the cutters around.

This sounds okay in theory. But in practice, it usually involves quite a bit of fiddling around with metal shims (spacers) to get a perfect fit.

For sources of reversible bits, see page 31.



Shop Solutions

TIPS FROM OUR SHOP

ROUTING JIG

• Cutting the recesses for the brass plates on the torpedo level (page 6) is easy. I just used a router and a straight bit.

The trick is getting a seamless fit between the wood body and the curved ends of the brass plates. To do this, I used a guide bushing that attaches to the base of the router and a simple jig, see photo at right.

JIG. The jig consists of two parts: a hardboard template with a curved notch and two sides that support the base of the router.

When determining the size of the curved notch, the thing to keep in mind is the bit won't cut right up next to the edge. That's because the guide bushing (not the bit) will ride against the template. As a result, the notch needs to be slightly *larger* than the desired radius of the recess.

To find out how much larger, measure the distance from the cutting edge of the bit to the outer part of the bushing. Then add that amount to the desired radius of the recess.

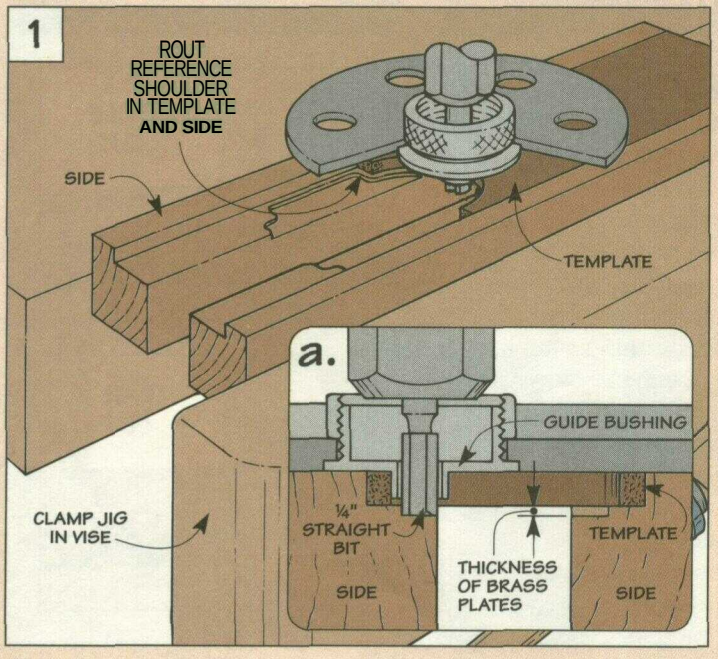
RABBETS. After cutting the curved notch, the template is glued into rabbets cut in the sides of the jig. These rabbets are sized so the sides of the jig fit snug against the level. This way, the workpiece will be pinched between the sides when you tighten the jig in a vise.

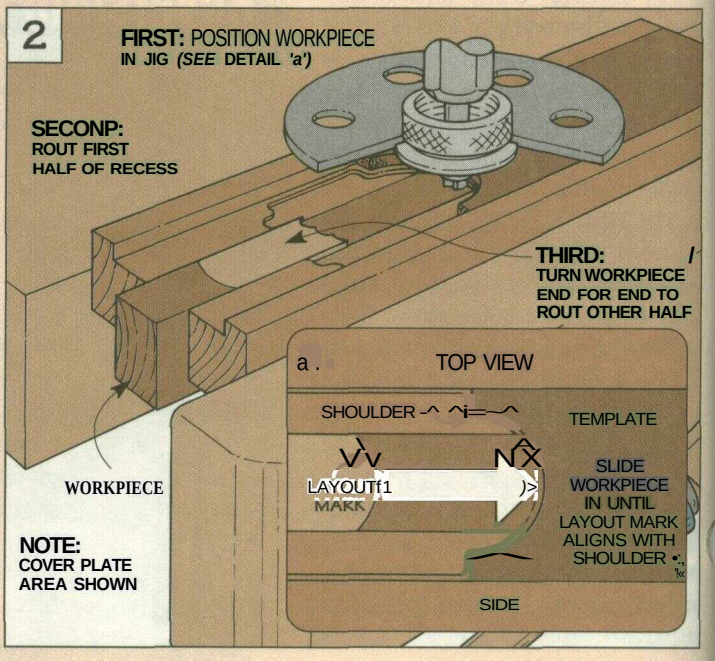
REFERENCE SHOULDER. Before routing the recess, the next step is to establish a reference shoulder that will help you accurately position the workpiece in the jig.

To create this shoulder, rout along the template and sides of the jig *without* the workpiece in place, see Fig 1. Note: The depth of cut should equal the thickness of the brass plates, see Fig. la.

ROUT RECESSES. Now it's just a matter of routing the recesses. After laying out each recess (refer to margin on page 10), position the workpiece in the jig so the mark aligns with the reference shoulder, see Fig. 2a. After tightening the jig (and workpiece) in a vise, you can rout two recesses on the bottom for the wear plates.

To rout the recess for the cover plate, you'll need to first rout half the recess, see Fig 2. Then, turn the workpiece end for end and rout the other half.



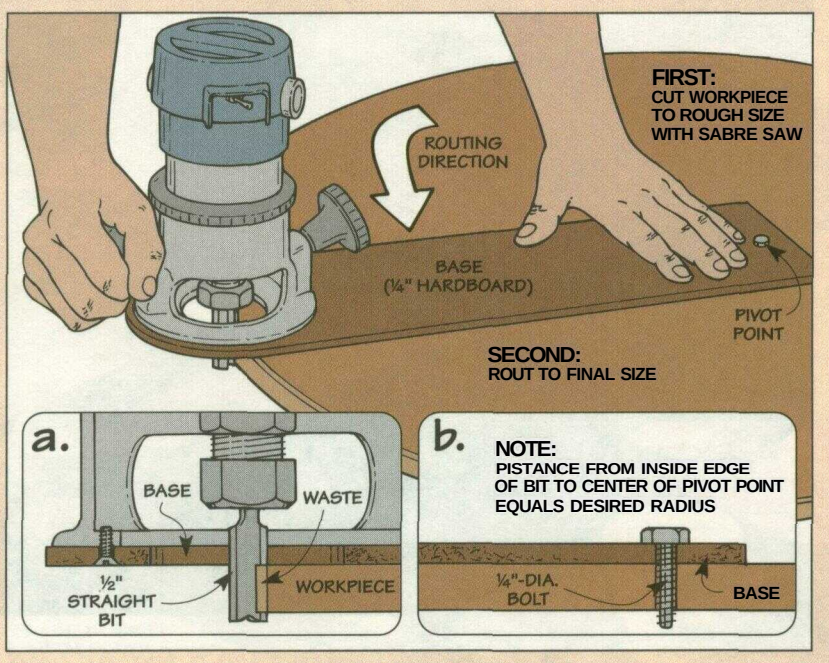

2
FIRST: POSITION WORKPIECE IN JIG (SEE DETAIL 'a')
SECONP: ROUT FIRST HALF OF RECESS
THIRD: TURN WORKPIECE END FOR END TO ROUT OTHER HALF
a. TOP VIEW
SHOULDER
TEMPLATE
WORKPIECE
LAYOUT MARK
SLIDE WORKPIECE IN UNTIL LAYOUT MARK ALIGNS WITH SHOULDER
NOTE: COVER PLATE AREA SHOWN
SIDE

CIRCLE CUTTING JIG

An easy way to cut the large circular workpieces on the revolving tool station (page 16) is to use a router that's mounted to a simple jig, see drawing.

The jig is just a hardboard base that pivots on a bolt. This bolt passes through the base and into a centered hole drilled in the workpiece. To determine the location of the hole in the base, you'll need to know the radius of the workpiece. The hole is drilled that same distance away from the *inside* edge of a straight bit, see details 'a' and V

ROUT. Before routing the circle, it's a good idea to first cut the workpiece to rough size. (I used a sabre saw.) This way, there's not as much material to remove as you rout it to final size.

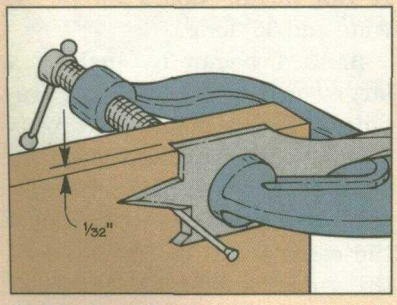


MODIFYING A SPADE DIT

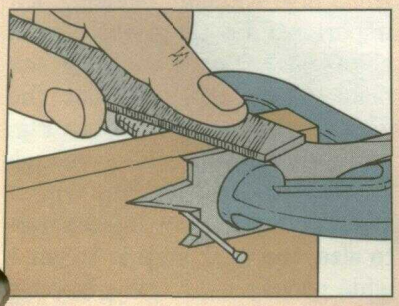
I wanted the wood collar b'locks on the tool station (page 16) to fit snug around the iron pipe. But I ran into a snag when it came time to drill the holes for the pipe. There wasn't a spade bit available that matched the iVie" outside diameter of the pipe. So I modified a larger (iVs"-dia.) spade bit by filing the sides until it was the correct size.

To ensure that the bit is balanced and cuts evenly, the important thing is to remove the same amount of material from each side. A handy way to do this is to use a nail and a scrap block to position the bit, see drawings at lower left.

After filing one side down to the top of the scrap block, repeat the process on the other side.



A *Use a nail to position the side of the spade bit 1/32" above a scrap and clamp the bit in place.*



A *After filing one side of the bit flush with the scrap, repeat the process for the other side.*

TUBE LEVEL

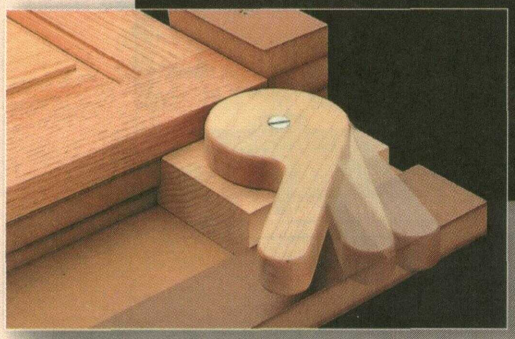
• Before you can get an accurate reading on the torpedo level (page 6), you'll need to check it on a known level surface and adjust it if necessary.

One way to establish a level surface is to use a clear plastic tube filled with water. The basic principle here is simple — water finds its own level.

To take advantage of this, fit the ends of the tube into notches in a *flat* piece of plywood and add water (a drop or two of food coloring makes it easy to read the level).

Then slide one end of the tube up or down until the water column is flush with the surface of the plywood. This will move the water column at the opposite end either higher or lower. To create a level surface, just shim the "high" side until the water columns are equal. (I used playing cards.)

Frame & Panel Jig



Gluing up a frame and panel door with this jig is a snap. With two cams applying pressure, the jig squares up the door and keeps it flat.

Gluing up a frame and panel door can be a challenge. Even if the frame pieces that surround the panel fit nice and tight, sometimes it's still hard to get the door perfectly square and flat.

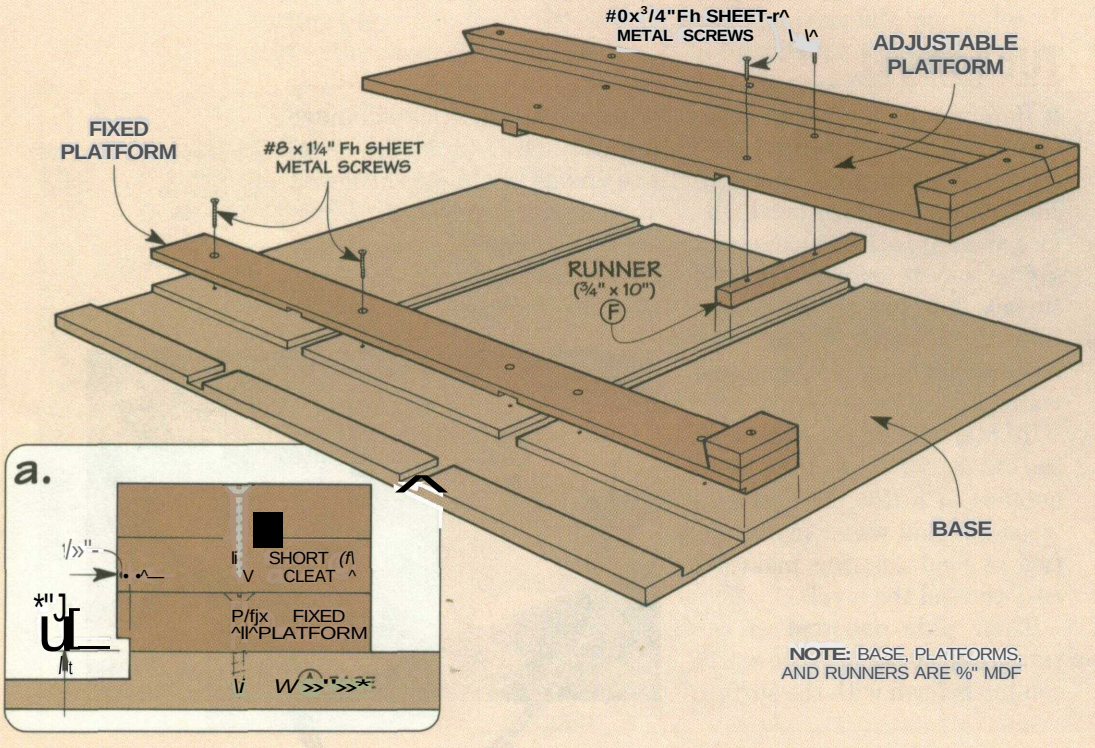
This frame and panel jig solves both problems, see photo above. To keep the door *square*, it's tucked into a 90° "corner pocket." And to ensure that it stays *flat*, two cams apply pressure that's centered on the thickness of the frame, see inset photo.

Design Note: This jig is designed for doors with $^{3}/4^{M}$-thick frames. It can handle doors up to 24" wide and 36" long.

BASE. I began by making a large *base (A)* for the jig. It provides a foundation for two platforms — one fixed and the other adjustable, see drawing. In addition, the base serves as a track for the cams and a pair of runners that guide the adjustable platform.

These runners fit in dadoes in the base and adjustable platform. To get the runners to slide smoothly without binding, it's important for these dadoes to align. So I started with a large blank of *%"* MDF and cut the dadoes at the same time, see Fig. 1. Note: The blank is large enough for the base and *both* platforms.

GROOVE. After cutting the base to size, the next step is to cut a wide groove near one edge, see Figs. 1 and la. This groove guides the mounting blocks for the cams that are added later.



NOTE: BASE, PLATFORMS, AND RUNNERS ARE %" MDF

A PLATFORMS. With the base complete, you can turn your attention to the two platforms. Besides raising the door off the base, the platforms support a system of cleats that keep the frame square.

Both platforms are made from the remaining piece of the blank used for the base. But before cutting it into two pieces, it's best to attach the cleats to ensure that they will align with each other.

CLEATS. The cleats start out as a long blank that's made by gluing and screwing two strips of $^{3}/_{4}$" MDF together, see Fig. 2. To help keep the door flat against the base, one edge of the blank is beveled, see Fig. 2a. Then the *long (B)* and *short cleat (C)* are simply cut to length.

Before attaching the cleats, there's one more thing to do. That's to bevel the end of the short cleat so it fits against the edge of the long cleat, see Figs. 2b and 3.

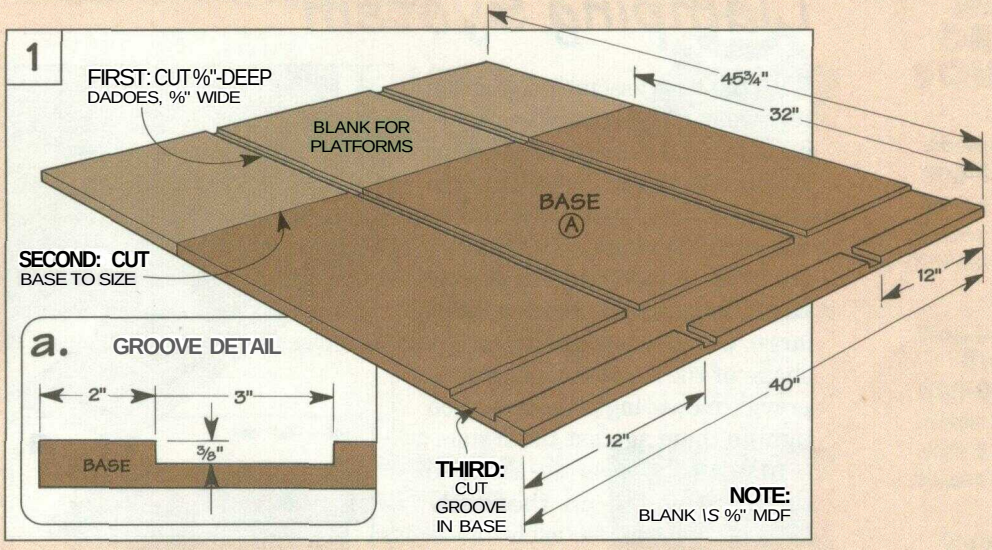
ATTACH CLEATS. Now you can attach the cleats. The important thing here is that the corner formed by the cleats is square. This way, the door that's glued up will be perfectly square too.

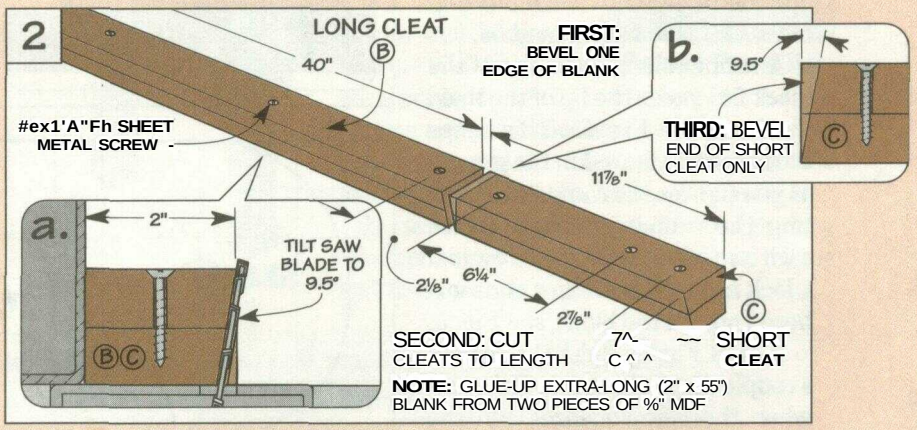
After gluing and screwing the cleats in place, you can rip the blank into two pieces: a narrow *fixed platform (D),* and a wide *adjustable platform (E),* see Fig. 4.

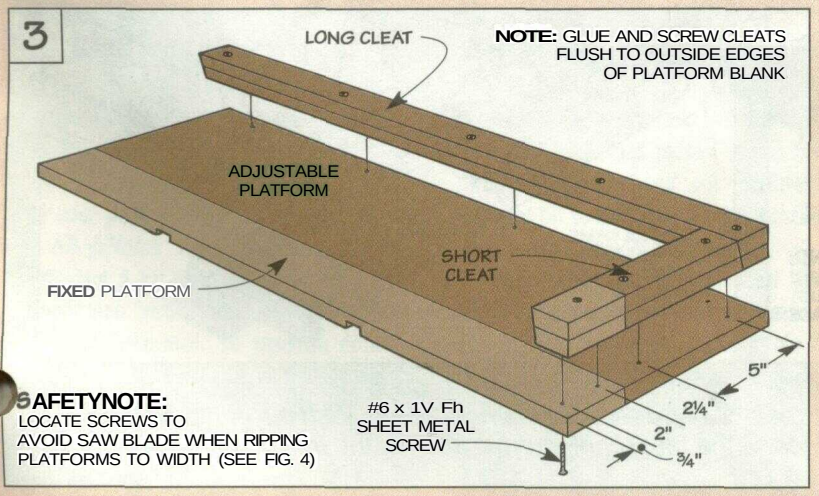
RUNNERS. To complete the adjustable platform, you'll need to add the two *runners (F),* see drawing on opposite page. These are nothing more than strips of MDF that are cut to fit the dadoes in the adjustable platform.

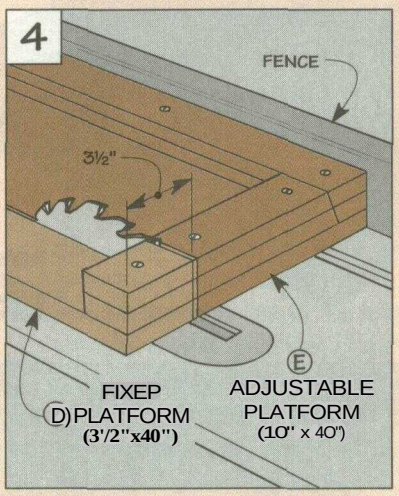
ATTACH FIXED PLATFORM. All that's left is to attach the fixed platform to the base. This platform has a small lip that overhangs the groove in the base, see detail 'a' in drawing on page 28. Later, this lip traps the mounting blocks for the cams in the groove.

To form this lip, simply rabbet the bottom edge of the fixed platform (D), then screw it in place.









Clamping System

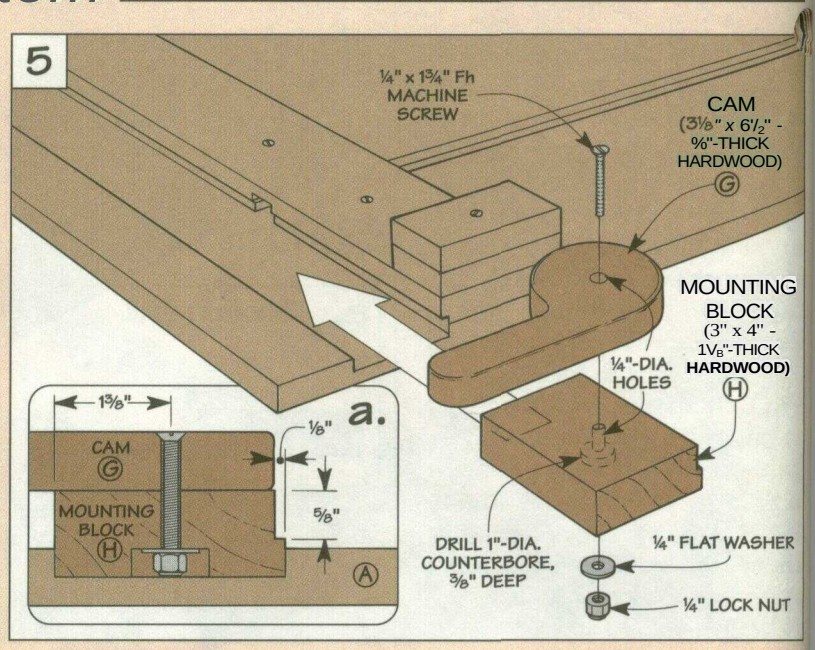
With the base assembled, you can turn your attention to the clamping system. It consists of two cams attached to blocks that slide in the groove in the base, see Fig. 5.

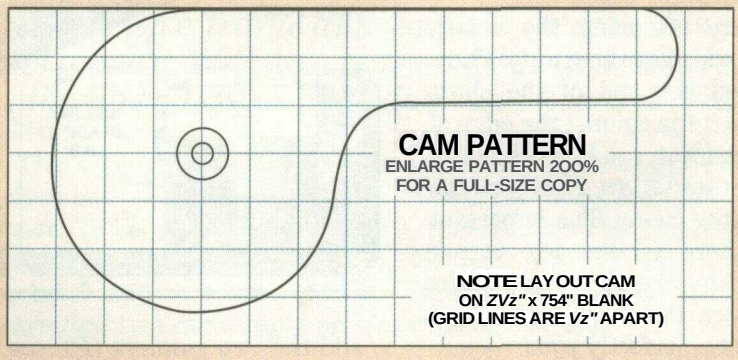
CAMS. The *cams (G)* are nothing more than 3/4"-thick pieces of hardwood that are shaped like a large whistle, see pattern. The shape of the cams is designed to provide increasing pressure as you tighten them against the frame.

BLOCKS. To raise the cams so they're centered on the thickness of the frames, each one is attached to a hardwood *mounting block (H),* see Figs. 5 and 5a.

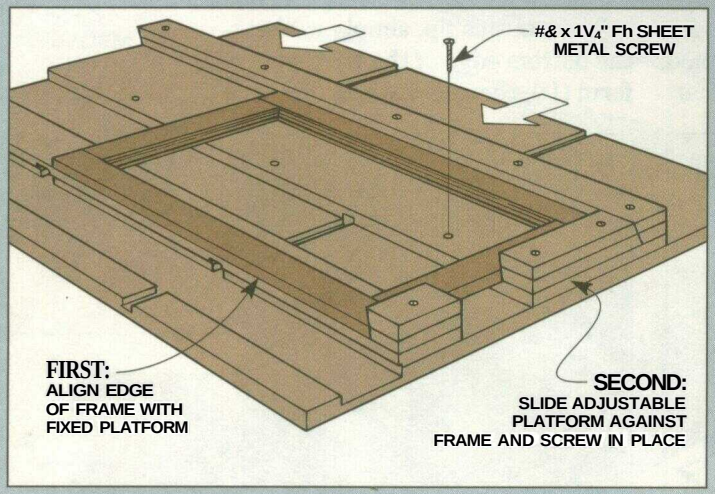
A rabbet along one edge of the block fits under the lip of the fixed platform, see Fig. 5a. This keeps the assembly locked in the groove as you tighten the cams. After cutting the rabbet, you can attach each cam with a machine screw and a lock nut that rests in a counterbored hole in the block, see Fig. 5.

FINISH. Finally, finish the jig with a couple coats of varnish. This way, when the glue squeezes out, the frame won't stick to the jig. A

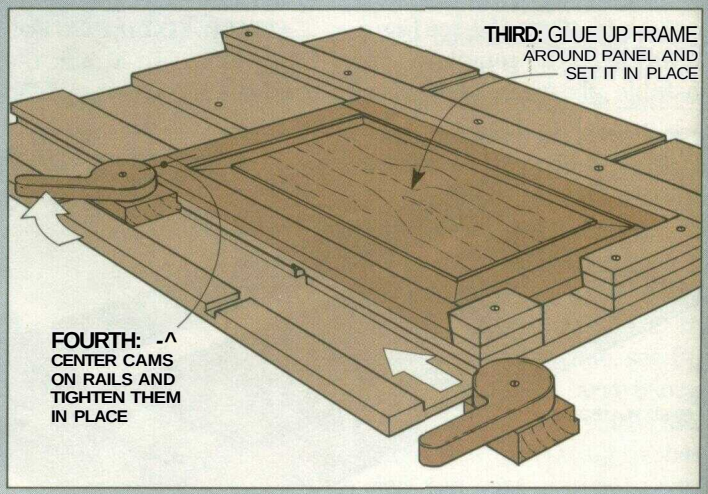




Using The Jig


#8 x 1¼" Fh SHEET METAL SCREW
FIRST: ALIGN EDGE OF FRAME WITH FIXED PLATFORM
SECOND: SLIDE ADJUSTABLE PLATFORM AGAINST FRAME AND SCREW IN PLACE

1 *To set up the jig, position the frame so the edge of the stile aligns with the fixed platform. Then, slide the adjustable platform against the frame and screw it in place.*



2 *After assembling the door, place it against the cleats and slide the cams in place. With the cams centered on the rails, tighten them against the frame.*

Sources

PRODUCT INFORMATION

ShopNotes Project Supplies *is offering some of the hardware and supplies needed to build the projects in this issue. We've also put together a list of other mail order sources that have similar hardware and supplies.*

A Torpedo Level

Made of walnut and brass, the Torpedo Level (page 6) has the look and feel of a traditional hand tool. And it provides all the satisfaction that goes along with making a tool yourself.

ShopNotes Project Supplies is offering a kit that includes all the hardware you need to build the level. All you need to supply is the wood.

TORPEDO LEVEL KIT
6835-100.....$6.95

Roller Bearings for Tool Station >•

The Revolving Tool Station shown on page 16 uses a number of heavy-duty roller bearings (fourteen altogether) to support the carousel on top and the turntable underneath. Since the "ball" in each bearing spins freely in the metal cup, you can rotate the carousel (or turntable) to put the tool you need right at hand. These roller bearings are easily installed with two screws.

Roller bearings are available from many woodworking stores and from some of the mail order sources shown at right.

Stile Bit

Rail Bit

Frame & Panel Router Bits

Raised Panel Bit

A handy way to build frame and panel doors quickly and accurately is to use router bits that are specially designed for that purpose. To build a frame and panel door like the one featured on page 12, we used three different bits: a matched pair of stile and rail bits, and a raised panel bit.

These router bits are available through many woodworking stores and through some of the mail order sources listed in the margin.

MAIL ORDER SOURCES

Jesada Tools
800-531-5559
Stile & Rail Bits
Raised Panel Bits
Combination Bit

Woodworker's Supply
800-645-9292
Roller Bearings
Stile & Rail Bits
Raised Panel Bits

Woodcraft
800-225-1153
Roller Bearings
Stile & Rail Bits
Vertical Panel Bits

Trendlines
800-767-9999
Stile & Rail Bits
fV/ *shanks)*
Raised Panel Bits

Woodhaven
800-344-6657
Vertical Panel Bits
Stile & Rail Bits
Raised Panel Bits

Selected Guide to Past Projects

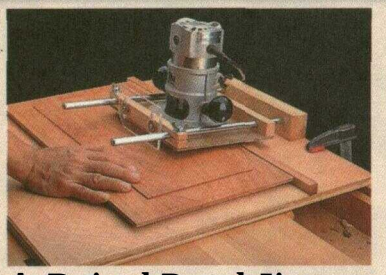
These jigs and accessories featured in past issues of ShopNotes are sure to come in handy as you build some of the projects shown in this issue.

A Router Trammel

When cutting a workpiece to circular shape (like the pieces for the Tool Station for example), you can use this shop-made Router Trammel to rout perfect circles and arcs.

ShopNotes Project Supplies is offering a kit that includes all the hardware you need to build the Router Trammel. To provide complete step by step plans, *ShopNotes* No. 3 is also included in this kit.

ROUTER TRAMMEL KIT
6803-225.....$6.95

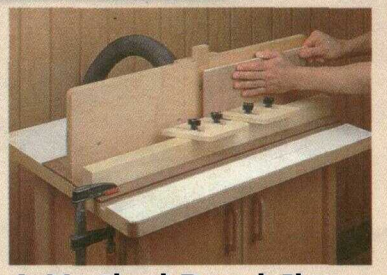


A Raised Panel Jig

This Raised Panel Jig makes it easy to rout a raised panel. But instead of using a special raised panel bit (page 15), it uses an ordinary straight bit to create a beveled profile around the edges of the panel.

We're offering a kit with all the hardware needed to build the Raised Panel Jig. Also, *ShopNotes* No.7 is included to provide complete instructions on building the jig.

RAISED PANEL JIG KIT
6807-125.....$22.95



A Vertical Panel Jig

This Vertical Panel Jig is designed to use *vertical* raised panel bits to rout a decorative raised panel. Unlike horizontal raised panel bits (see page 15), these bits can be used with a single-speed router. (For mail order sources, see margin.)

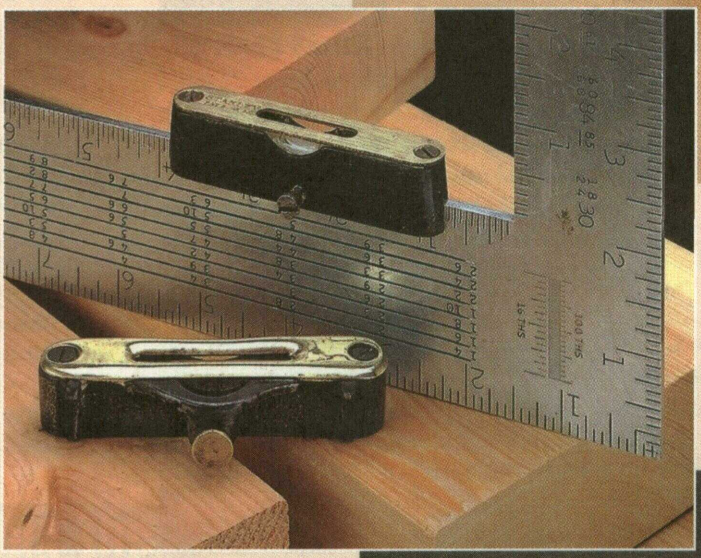
A kit that includes all the hardware you need to build this jig is still available. It also includes *ShopNotes* No. 9 with detailed step by step plans.

VERTICAL PANEL JIG KIT
6809-125.....$! 6.95

I >OE AN O RQEP O ALL ? 800-347-1010

Scenes from the Shop

*Beginning in the 1930's, *» these torpedo levels were a standard item in most any toolbox. Made of either aluminum or wood, they were used extensively by carpenters, plumbers, and electricians. The shape of these levels provided the inspiration for the shop-made level shown on page 6.*



*** A groove in the bottom of each of these small pocket levels was designed to fit onto the blade of a framing square. After tightening a simple screw to hold the level in place, a carpenter could quickly estimate the pitch of a roof.*

Around the turn of the +» century, machinists relied on these precision levels to set up and test machinery. With their cast iron bodies and fittings of brass and steel, these old levels are a convincing reminder of the pride in workmanship that goes into a well-made tool.